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September 15, 1987

Mr. William J. Tricarico
Secretary
Federal Communications Commission
1919 M Street, N.W.
Washington, D.C. 20554

Re: Application of National Exchange, Inc. for Authority to Construct, Launch and Operate a 4/6-GHz and 12/14-GHz Hybrid Satellite System in the Domestic Fixed-Satellite Service

Dear Mr. Secretary:

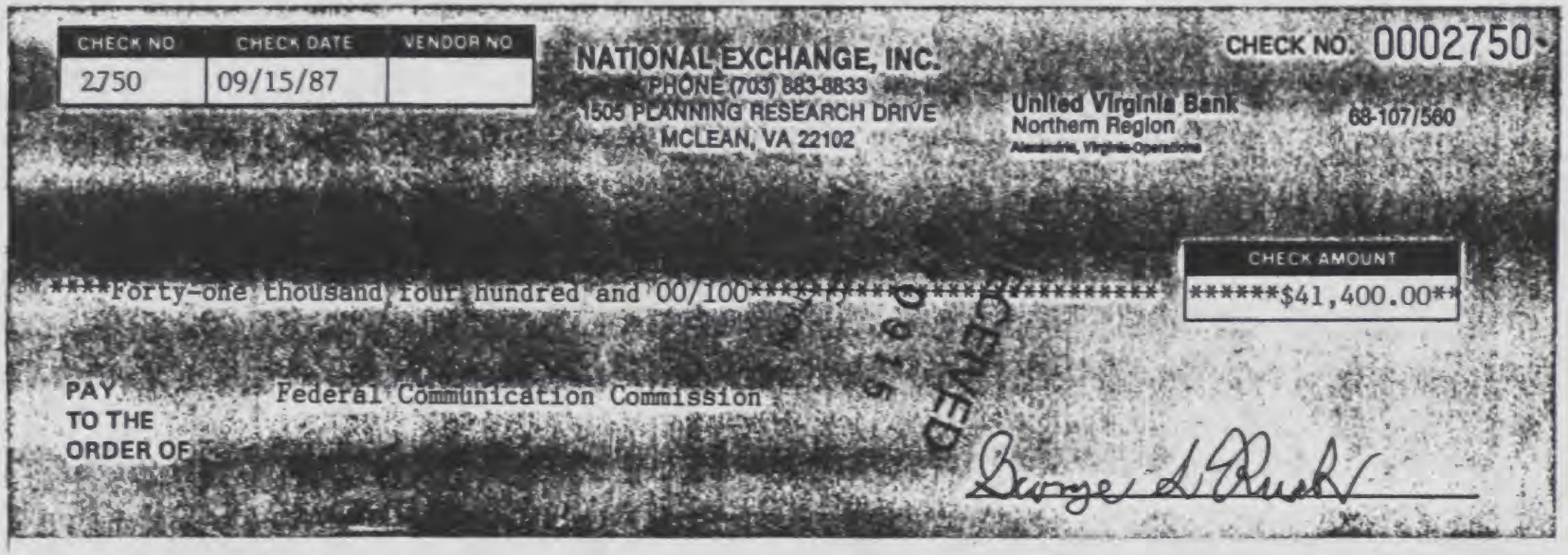
Transmitted herewith for filing on behalf of National Exchange, Inc. ("NEX") are an original and two copies of an application requesting authority to construct, launch and operate two hybrid domestic fixed-service satellites and to construct one hybrid ground-spare. The application is comprised of four basic parts. Part I presents an overview of the entire proposed system, including the basic required information regarding NEX's legal, financial and technical qualifications. Part II is an application to construct, launch and operate "SpotNet 1", a hybrid satellite operating in both the 4/6-GHz and 12/14-GHz bands, at 101° W.L. Part III is an application to construct, launch and operate "SpotNet 2", a hybrid satellite operating in both the 4/6-GHz and 12/14-GHz bands, at 93° W.L. Part IV is an application to construct "SpotNet 3", a hybrid satellite operating in both the 4/6-GHz and 12/14-GHz bands, as a ground-spare.

Submitted herewith is a check in the amount of $41,400.00 to cover the appropriate filing fees for three requests for construction permits and two requests for launch and operational authority.

If there are any questions regarding this matter, please contact the undersigned.

Respectfully submitted,

Jeffrey H. Olson
Counsel for
National Exchange, Inc.



CHECK NO	CHECK DATE	VENDOR NO
2750	09/15/87	

NATIONAL EXCHANGE, INC.
PHONE (703) 883-8833
1505 PLANNING RESEARCH DRIVE
MCLEAN, VA 22102

CHECK NO. 0002750

United Virginia Bank
Northern Region
Alexandria, Virginia Operations

68-107/560

CHECK AMOUNT
******$41,400.00**

****Forty-one thousand four hundred and 00/100*****

PAY TO THE ORDER OF Federal Communication Commission

VOID AFTER 90 DAYS

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SUMMARY

In 1983, National Exchange, Inc. ("NEX"), filed a series of applications requesting authority to construct and operate a new, technologically-advanced spot beam satellite system called "SpotNet". The proposed system, as initially described, was comprised of four in-orbit 12/14-GHz satellites and two in-orbit 4/6-GHz satellites, situated at only two orbital slots (two Ku-Band and one C-Band at each), and one ground-spare in each band. See FCC File Nos. 1824/1825-DSS-P/LA-83, 1828-DSS-P-83. This proposal was later modified to encompass only two Ku-Band and one C-Band in-orbit satellites.

Despite the significant technological and economic advantages offered by the SpotNet system, the Commission denied NEX's applications, based on what the Commission found to be NEX's lack of financial qualifications. See National Exchange, Inc., FCC 85-417, released August 29, 1985, reconsideration denied, 1 FCC Rcd 682 (1986); see also Licensing Space Stations in the Domestic Fixed-Satellite Service, 58 R.R.2d 1267 (1985), reconsideration denied, 1 FCC Rcd 682 (1986). Subsequently, a majority interest in NEX was acquired by Burlington Northern, Inc. ("BNI"), and BNI represented to the Commission that it would provide the necessary financial support for NEX's proposed satellite system (there was no question of BNI's financial capacity to do so). This effort to satisfy the Commission's concerns regarding NEX's financial qualifications was rejected on the ground that it came too late in

the process. See National Exchange, Inc., supra, 1 FCC Rcd at 689 n.34.

Now, premised in part on the Commission's suggestion that those applicants who were found to be financially unqualified in the 1983 processing round should redouble their efforts and apply again during the next round, see Licensing Space Stations in the Domestic Fixed-Satellite Service, 58 R.R.2d 1267, 1271 & n.17 (1985), NEX has, with the continued backing of BNI, reassessed the changing marketplace conditions, refined its SpotNet proposal accordingly and, in response to the Commission's Public Notice, Report No. DS-635, released June 10, 1987 ("Notice"), herewith submits a new SpotNet application, requesting authority for two in-orbit hybrid satellites and one hybrid ground-spare. Use of 4/6-GHz and 12/14-GHz hybrid satellites, with spot beam configuration in the Ku-band, will create a superior system in terms of service to the public and efficient spectrum utilization. Not only will the user be able to enjoy a substantially wider variety of telecommunications services, but in addition, those services can be provided in whichever band is the most efficient for that service.

Because of the need for frequency coordination with users of terrestrial microwave, most 4/6-GHz services employ relatively few uplink locations. The 4/6-GHz segment is useful primarily for high-traffic-density, point-to-point services and for nationwide video distribution services. Where large antennas can be installed and justified economically, 4/6-GHz continental coverage

beams can provide efficient spectrum use for point-to-point services. In most point-to-point applications, however, there is not enough traffic to justify a large earth station, and using continental coverage beams to carry services from one office to another with small antennas can, in many instances, be exceedingly wasteful of spectrum.

The SpotNet hybrid system, at orbital locations which can accommodate both 4/6-GHz and 12/14-GHz facilities, will be used as an integrated system. Users can employ 4/6-GHz, 12/14-GHz and/or 4/6-GHz-12/14-GHz combination earth stations, all aimed only at one satellite, in order to access whichever frequency band is appropriate for the required service. The 4/6-GHz capacity will be used primarily for point-to-multipoint broadband distribution services, such as analog video distribution, and for high-density point-to-point trunking (particularly into areas of high rainfall). The 12/14-GHz capacity will be used primarily for low-density, point-to-point voice, text, facsimile and teleconferencing services. A portion of the C-Band capacity will in part provide backup for Ku-Band services during periods of high rainfall. Such backup can be used to cover all Ku-Band spot beams efficiently, because of the C-Band's nationwide coverage and the low probability of high rain attenuation in many geographic locations simultaneously.

NEX presently is assessing user demand for cross-strapped 4/6-GHz and 12/14-GHz service (e.g., for remote video backhaul uplinking in Ku-band, with C-band distribution). At the

completion of this process, it is likely that the satellite design will be modified to include such cross-strapped capability.

The instant application is organized in the format established by Filing of Applications for New Space Stations in the Domestic Fixed-Satellite Service, 93 F.C.C.2d 1260 (1983) ("1983 Processing Order"). Part I provides a system overview, including materials relating to NEX's legal, financial and technical qualifications. Part II presents the application for SpotNet 1, which is proposed to be located at 101°W.L. Part III presents the application for SpotNet 2, which is proposed to be located at 93° W.L. Part IV presents the application for SpotNet 3, the system's ground-spare. Technical and engineering analyses contained in the application, including the spacecraft technical studies, spot beam coverage predictions and interference analyses relevant to the requirement of Licensing of Space Stations in the Domestic Fixed-Satellite Service, 54 R.R.2d 577 (1983) ("2° Order"), have been performed by NEX's technical consultants: Rubin, Bednarek & Associates, Washington, D.C.; David Wright of DataWrights, Solana Beach, California; M/A-COM Linkabit, Inc., San Diego, California; the Spacecraft Engineering Division of Telesat Canada, Ottawa, Canada; and Dale N. Hatfield Associates, Boulder, Colorado. Philip A. Rubin of Rubin, Bednarek & Associates oversaw the final compilation of the technical material.

I. THE SPOTNET SATELLITE SYSTEM.

A. Applicant Name and Address.

National Exchange, Inc.
1505 Planning Research Drive
McLean, Virginia 22102
(703) 883-8833

B. Correspondence.

Correspondence relating to this application should be sent to the following person at the address in Paragraph 1 above (unless otherwise indicated):

George S. Kush
Executive Vice President

with a copy to:

Henry Goldberg, Esq.
Jeffrey H. Olson, Esq.
Goldberg & Spector
1229 Nineteenth Street, N.W.
Washington, D.C. 20036
(202) 429-4900

C. General Description of Overall System Facilities, Operations, and Services.

1. System Facilities and Operations.

In this Application, National Exchange, Inc. ("NEX"), is applying for authority to construct and operate a satellite system employing levels of technical sophistication well beyond anything presently in operation. Known as "SpotNet," the NEX system represents a significant advance in satellite communications

system design and use, thereby providing great benefits to customers of satellite services and the public at large.

The key features that are unique to the SpotNet system are (1) the use of multiple Ku-Band coverage patterns that are adapted to the traffic load of the United States; (2) a frequency domain method of switching traffic between those patterns which requires no active control at the satellite; (3) figure-of-merit and EIRP-per-Hertz ratings that permit access to the network with small customer-premise transmit/receive earth stations, which, unlike present hub-and-spoke VSAT networks, will allow full interconnectivity among such small earth stations; and (4) multiple reuse of orbital frequencies such that up to 4,000 MHz of usable bandwidth is available for the Ku-Band service at each orbital location (instead of the 1,000 MHz available with conventional satellite design). These features make the SpotNet system capable of far more extensive and effective use of orbital and frequency resources than any other present or proposed satellite system, domestic or international.

The SpotNet satellite configuration described herein is based on studies of traffic types and densities across the U.S., and reflects a design that meets those traffic needs. However, the final payload configuration may vary, based on detailed design studies performed by the satellite manufacturer in order to achieve the best balance of traffic flexibility, cost, complexity, and performances, particularly at Ku-Band.

The SpotNet space segment will consist of two in-orbit satellites, each operating in the 12/14 GHz frequency range and in the 4/6 GHz frequency range. NEX requests that the SpotNet satellites be assigned to operate from two orbital positions, one at 101° W.L. and one at 93° W.L., both having the capacity to provide full CONUS coverage plus service to Puerto Rico, the Virgin Islands, Hawaii and major portions of southern Alaska. The satellites will have encrypted telemetry, tracking and command ("TT&C") circuits, and all signalling channels will be encrypted as well. Domestic ELVs will be the prime candidates for launching the SpotNet satellites; they will also be compatible with the Ariane and the Long March vehicles. NEX plans to launch its first satellite during 1993 or early 1994.

a. Ku-Band.

Each SpotNet satellite will support eighteen distinct coverage patterns for the Ku-Band service. These patterns range in size from very small near-circular spots covering eastern and western urban areas to one-fifth CONUS coverage of areas with lower population density. These patterns are the outcome of analyses conducted by NEX as to how best to provide spot beam service to the United States and reflect an excellent correlation between the traffic base and the capacity of the satellite. The satellite antenna gains for these patterns range from 7 dB to 21 dB higher than for single pattern coverage of CONUS and, thus, permit the satellite's Ku-Band downlink power to be used very

effectively, making practical the use of small aperture earth stations with moderately sized final amplifiers. Moreover, the smaller coverage patterns permit frequency reuse, in a manner analogous to that used for cellular telephone systems.

High reliability, low cost and low maintenance will be essential features of the Ku-Band portion of the SpotNet system. In some situations, customer locations will have multiple antennas, which -- depending on which satellite(s) the antennas are pointed toward and which frequency band(s) they are operating in -- will allow simultaneous operation with satellites in both orbital positions (enhancing routing diversity), add reliability during rainstorms, and/or avoid sun-outage and eclipse interruptions. In addition, the 4/6-GHz capability will substantially increase the routing diversity and rain/sun-outage and eclipse protection that will be available for the overall SpotNet system. The system thus offers flexibility of routing and redundancy that is unusually innovative and responsive to customer needs.

b. C-Band.

The SpotNet C-Band subsystem will utilize conventional CONUS-wide beams, with spot beams for southern Alaska, Hawaii, Puerto Rico and the Virgin Islands. Each transponder will use a 9-watt solid state power amplifier and 36-MHz bandwidth, and one or more transponders will feed each of the beams. The transponders will be linearly cross-polarized, 12 vertical and 12 horizontal, for

1,000 MHz effective C-band bandwidth for each satellite at each orbital location.

c. TT&C and NCC.

The ground segment of the SpotNet satellite system will consist of two TT&C earth stations for tracking, monitoring, range-finding and command functions. Each TT&C station will include two 5.5-meter diameter antennas, operating in the 12/14-GHz frequency band. The TT&C station to be located on the East Coast will be designated the primary center, and will be co-located with one of two fully redundant Network Control Centers ("NCCs"). The NCCs will handle the functions associated with the allocation, assignment, and adjustment of SpotNet system capacity and characteristics. The TT&C station to be located on the West Coast, designated the secondary center, will be co-located with the second NCC, and will provide a redundant backup for all TT&C functions. All command channels will be encrypted to avoid unauthorized access and possible harm to the satellites.

2. Proposed Services.

As the American economy's demand for more sophisticated and efficient information technologies continues to grow, the existence of communications systems capable of supporting this demand will be of vital import. During the next decade, the expected use of wideband information services threatens to outpace the capacity and capability of the existing telecommunications network. Across-the-board increases in capacity -- both

terrestrial, particularly including costly optical fiber, and space-based -- will be required to meet the growing demand that is being driven by the rapid growth of business and institutional use of mainframe computers, minicomputers, personal computers, digital terminals, local area networks (LANs), digital PBX systems. As a whole generation of satellites are retired from service during the early to mid-1990s, renewal of this resource, particularly by satellites with expanded capabilities, is vital to the public interest.

NEX's satellite system will respond to this need. It will allow NEX to offer new services to virtually every business location in the country, at rates that are highly competitive with current rates offered on much more limited systems by carriers of intracompany information transmissions. The use of the system is expected to grow in tandem with the rapidly growing demand for wideband city-to-city communications, originating and terminating at customer-premises earth stations.

NEX anticipates that its Ku-Band system will serve primarily business users in the information industries, where users will be attracted by the substantial cost-savings and inherent flexibility associated with the SpotNet high-capacity spot beam design. The SpotNet Ku-Band capability also can provide economical service to small telephone companies in rural and remote areas, thus helping to ensure that residences and businesses in hard-to-serve areas will have access to the same low-cost, high-performance services

available in more populous regions. No other satellite system provides the Ku-Band EIRP, antenna gain, or flexibility of the SpotNet system. The spot beam design allows much less costly earth stations, thus allowing customers a lower overall circuit cost than other domestic satellite systems.

In addition to supplementing the Ku-Band capability for point-to-multipoint message distribution, the C-Band capability described herein will fill the need, anticipated for the 1993-94 period and beyond, for continuation of the current C-Band broadcast video distribution functions. Two of the major broadcast networks, CBS and ABC, currently depend, for all practical purposes, entirely on C-Band satellite capacity to distribute network programming; these facilities employ approximately 350 C-Band earth station antennas. The existing satellite transmission systems are expected to remain operative only until the 1994 time-frame at the latest, thus requiring that new C-Band capacity be available to insure uninterrupted service. Moreover, other major users of C-Band satellite capacity -- companies such as Hughes Television Network ("HTN"), which currently provides video backhaul service for sports events -- are similarly situated. They, too, are dependent on the continued existence of considerable C-Band satellite capacity in order to provide services to their customers.

The exact nature of the traffic being carried will depend on customer requirements, which will, in turn, determine the design of user earth terminals. For C-Band, stations may vary from 10-meters or smaller for analog video and FDM/FM telephony to 4.5-meter stations or smaller for TV, radio receive-only and narrowband SCPC telephony. For Ku-Band, 2.0-meter or smaller stations for 64 Kbps and 1.544 Mbps will be the norm.

D. General Technical Information

The SpotNet system will consist of two in-orbit hybrid satellites, with one proposed to operate at 101° W.L. and the other at 93° W.L. Overall coverage from these two orbital locations is shown in Figure 1. This application deals only with the space segment of the SpotNet system. Separate applications for the ground segment, including TT&C stations and customer-premise earth stations, will be filed in the future.

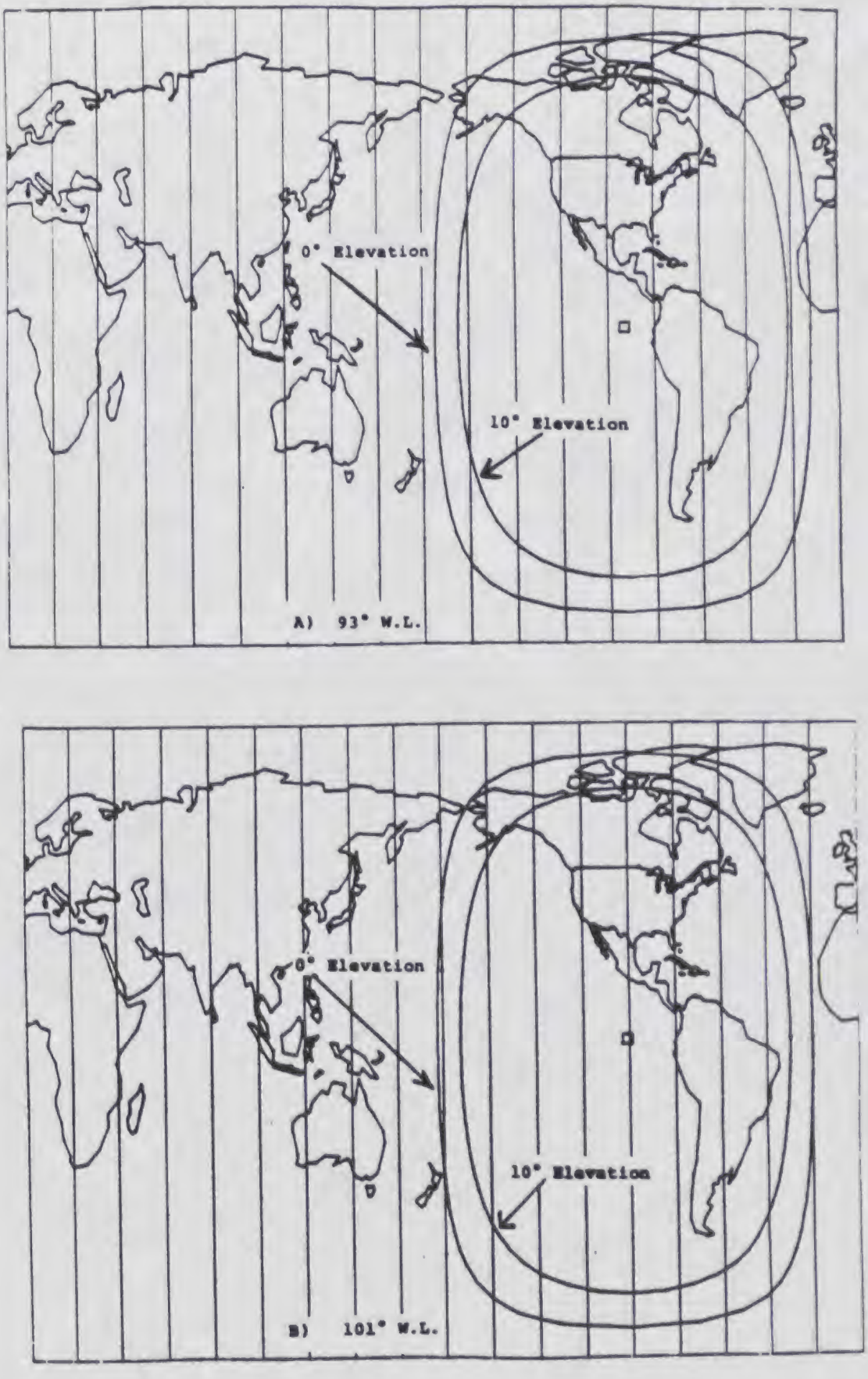


Figure 1. Satellite Coverage Contours

1. Radio Frequency Plan.

a. Ku-Band.

The eighteen SpotNet patterns are divided into two sets of nine each. One set, referred to as "beams" herein, has vertical polarization; the other set, "spots", is horizontally polarized. In the SpotNet architecture, the dense urban traffic is served by the higher gain spots while regional coverage is obtained by the lower gain beams. Based on traffic studies (and subject to change based on more detailed satellite design studies), the beams would be allocated a 167 MHz bandwidth, and the spots 250 MHz. The saturation boresight EIRP for the beams is 61 dBW, except for three beams west of the Mississippi, which are 60 dBW. The boresight EIRP is 63 dBW for each of the nine spots, reflecting the proportionately larger bandwidth available in a spot. The final amplifiers for the satellite downlinks are rated from 10 to 120 watts per pattern, which reflects the variation in antenna gain across the patterns.

The traditional concept of a "transponder" is inappropriate to the SpotNet Ku-Band payload, because of the separate handling of uplink and downlink processes by the SpotNet system. Based on the total reusable frequency, SpotNet's capacity would correspond to the equivalent of 90 transponders (prorated at the usual 12 per 500 MHz in current practice). Drawing a similar analogy, the proportional saturated EIRP for SpotNet is equivalent to 55 dBW per transponder on a conventional satellite with 36 MHz

transponders. Since all SpotNet downlinks are multi-carrier, the final amplifiers are always operated in a "backed-off" mode, such that the actual EIRP will not exceed the equivalent of 52 dBW in a conventional transponder; these figures are 1 dB less for the three beams west of the Mississippi.

By spatial isolation, the SpotNet Ku-Band payload design reuses the lower-half spectrum five times and the upper-half four times, and each of the third-band beam frequencies is reused three times. Altogether, the SpotNet design would provide a reuse ratio of 7.5 (accounting for both polarization and spatial separation) for a total workable bandwidth of 3,750 MHz. Depending on the final design chosen, this total workable bandwidth could vary from 2,000 to 4,000 MHz.

A functional block diagram of the SpotNet Ku-Band payload is shown at Figure 2. The overall use of the Ku-Band spectrum by space, polarity, and frequency is exhibited at Figure 3. The two in-orbit satellites and the ground spare will be identical in design and construction except for slight variations in the antenna patterns and for assignment of the frequency bands to spatial regions.

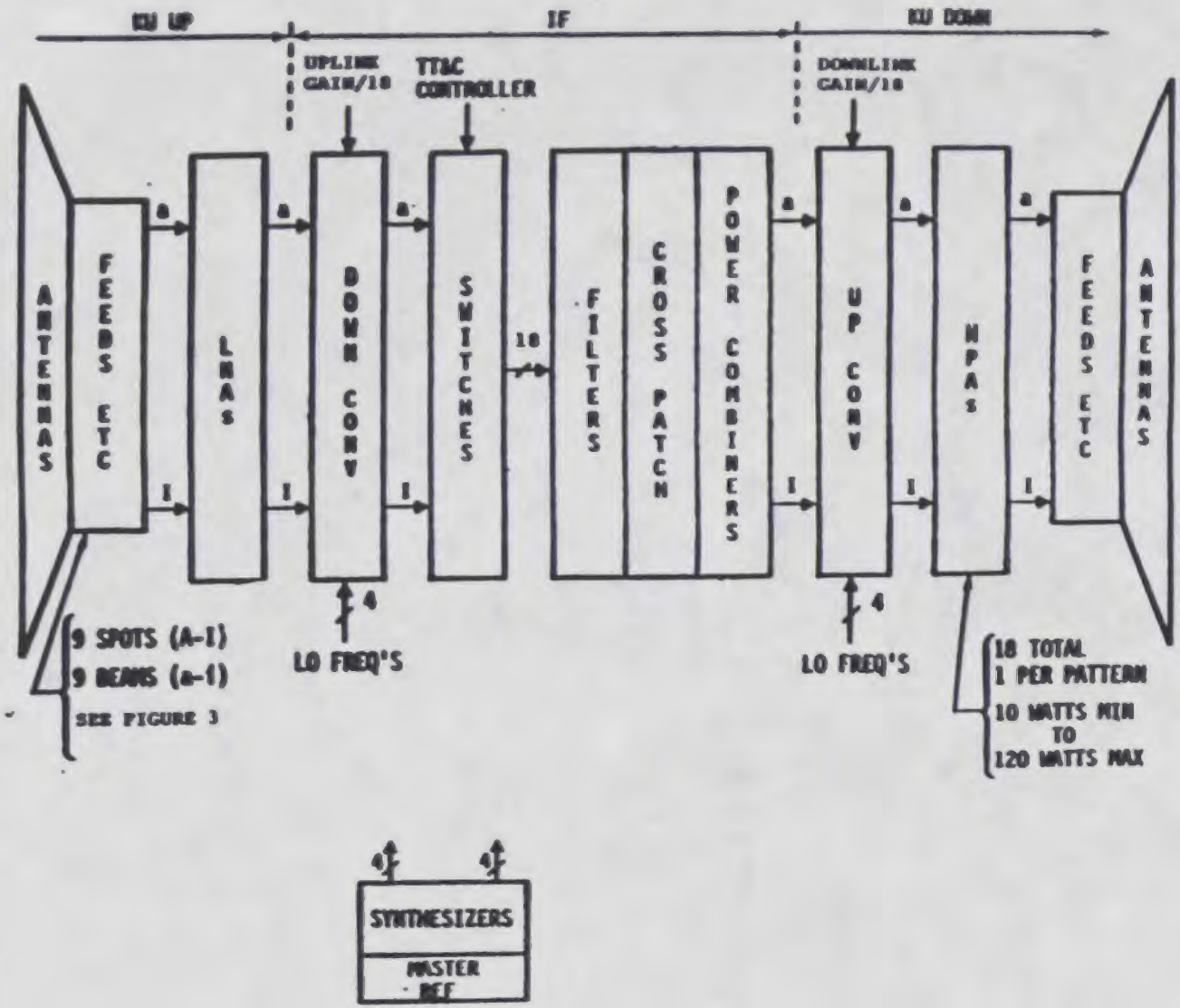
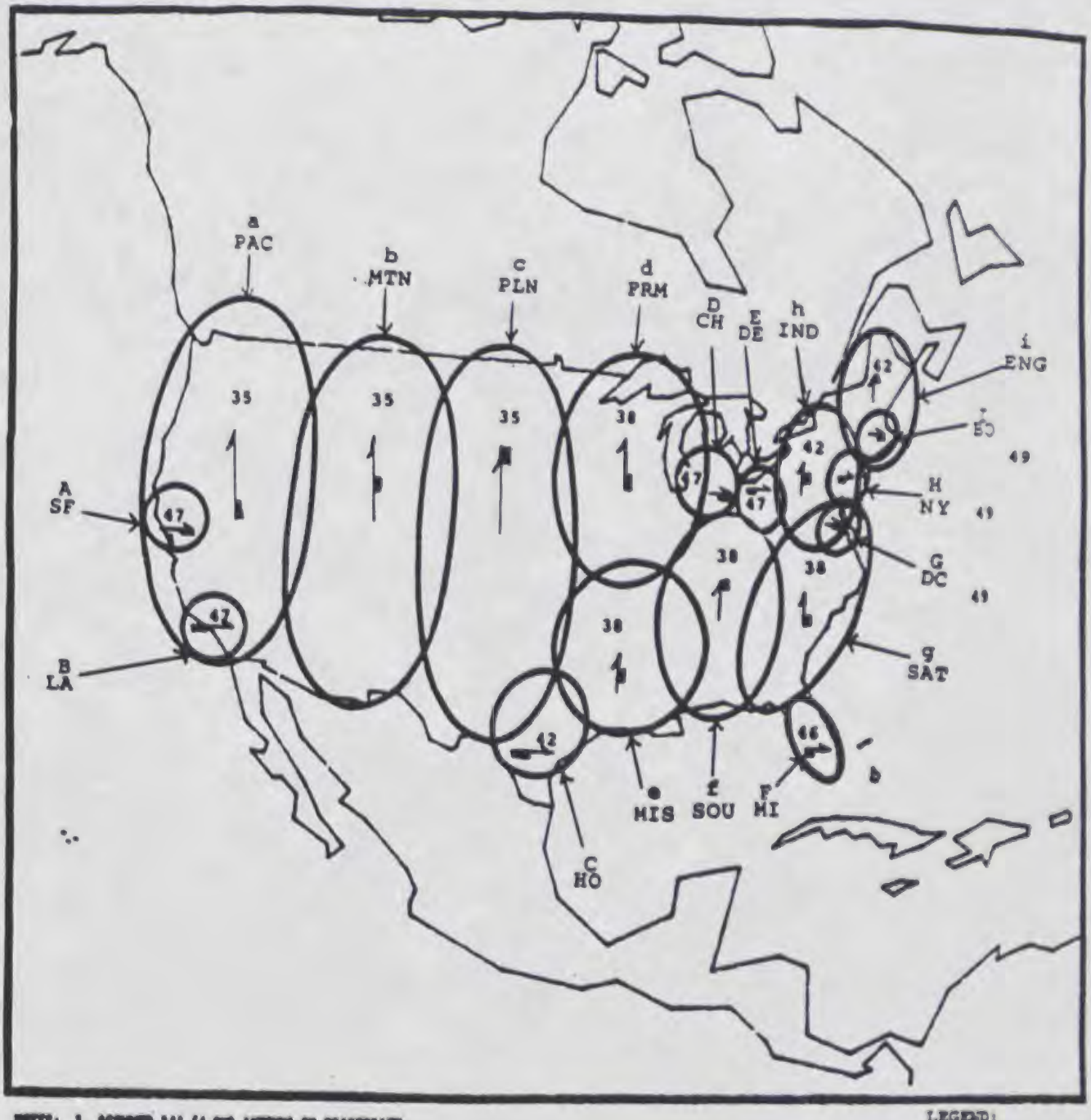


Figure 2. Organization of the Ku-Band Payload for Spotnet Satellite



NOTES: 1. ASSUMED 14° (4.5M) ANTENNA ON SPACECRAFT.

2. UPPER CASE DESIGNATES "SPOT" - HORIZONTALLY POLARIZED - 250 MBS BW'S.

3. LOWER CASE DESIGNATES "BEAM" - VERTICALLY POLARIZED - 167 MBS BW'S.

4 NUMBERS INDICATE ANTENNA DOWNLINK GAIN IN DBI.

POTENTIAL NOISE RATIO = 7.8

LEGEND:

- VERTICAL LOWER 3rd
- VERTICAL MIDDLE 3rd
- VERTICAL UPPER 3rd
- HORIZONTAL LOWER HALF
- HORIZONTAL UPPER HALF

Figure 3 Frequency and Polarization Usage

b. C-Band.

The SpotNet satellites will also operate in the 4/6-GHz bands (3,700-to-4,200-MHz space-to-earth and 5,925-to-6,425-MHz earth-to-space). A functional block diagram of the C-Band subsystem is shown in Figure 4. The frequency and polarizations of the 24 C-Band transponders is given in Figure 5. The frequency plan illustrated is similar to others currently in use or proposed, in that overlapping channels are cross-polarized to minimize interference between adjacent transponders. The frequency difference between adjacent co-polarized transponders will be 40 MHz, and between adjacent orthogonally-polarized transponders, 20 MHz. Each transponder will have a usable bandwidth of 36 MHz.

Emission designators for the various signals will depend on the bandwidth used and the type of signal or traffic being carried. In the case of the TT&C system, telemetry data will be angle-modulated and will use a bandwidth of 100 KHz.

For purposes of systems and interference analyses, it has been assumed that the C-Band transponders may carry any of the major modulation types identified in the FCC's report FCC/OST R83-2, May 1983, including FDM/FM, Video/FM (FM/TV), wideband digital and narrowband SCPC.

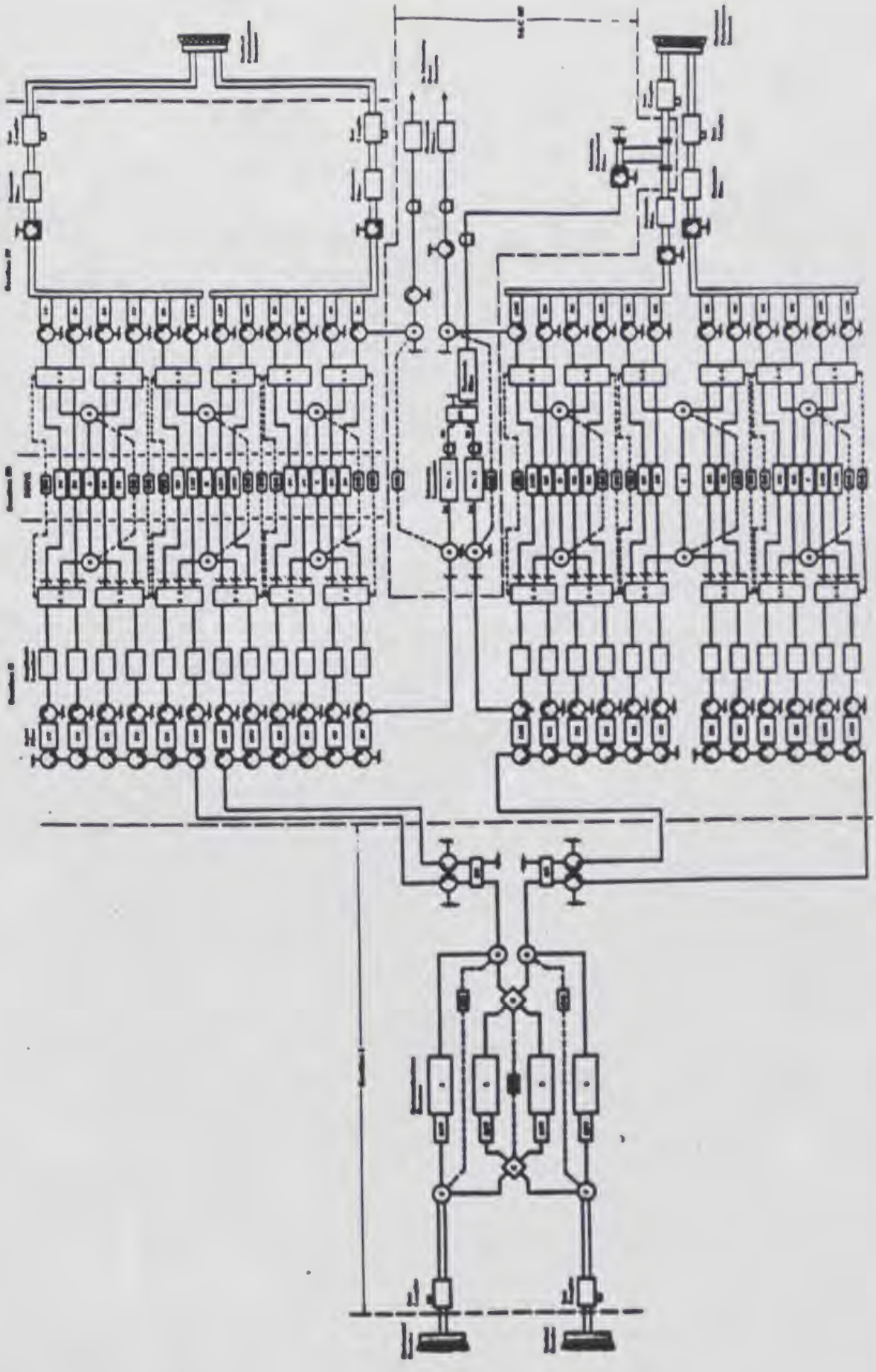
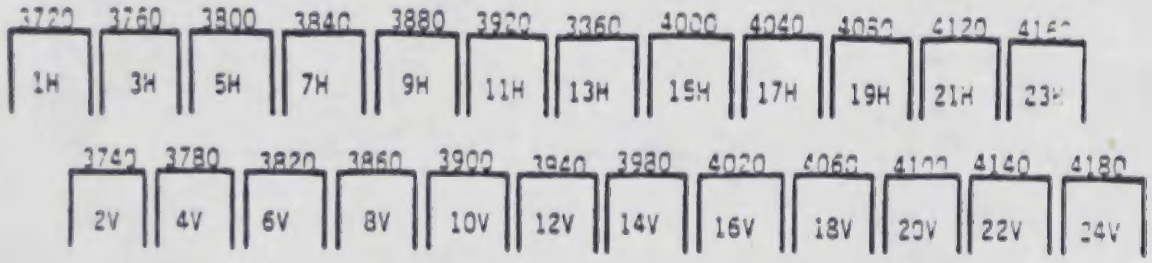
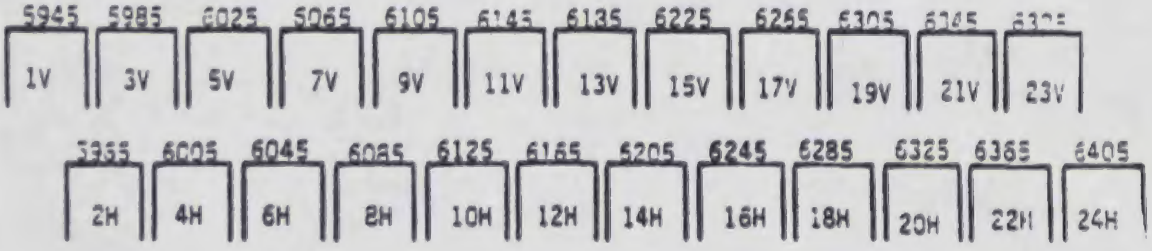


Figure 4. C-Band Subsystem



DOWNLINK CENTER FREQUENCIES & POLARIZATIONS



UPLINK CENTER FREQUENCIES & POLARIZATIONS

V = Vertical Polarization
H = Horizontal Polarization

COMMUNICATIONS
FREQUENCY AND POLARIZATION PLAN

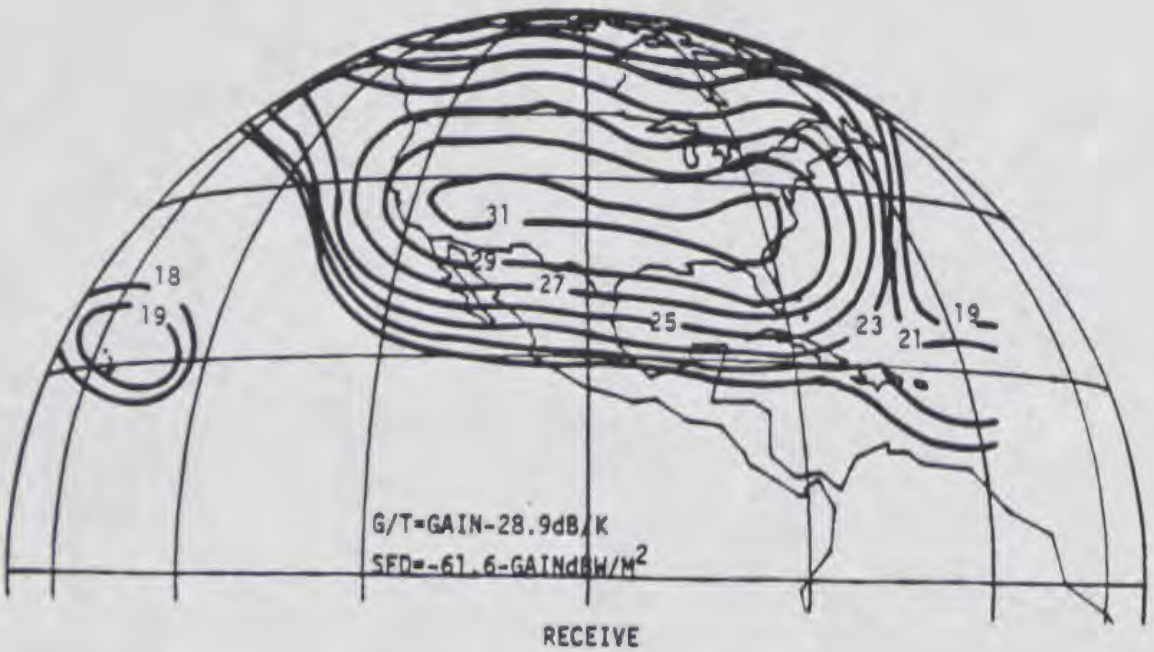
Figure 5.

In the FDM/FM mode, transponders can carry one or more carriers, depending on the nature and volume of traffic. In the TV/FM mode, each transponder may be carrying a single video channel and associated audio channel(s) occupying the entire transponder. In this mode, energy dispersal of 2 MHz will be employed to minimize interference to terrestrial microwave transmissions and to co-channel transponders, particularly those carrying single-channel-per-carrier (SCPC) traffic.

In the wideband digital mode, a transponder will be capable of handling many types of traffic from single digitized 56-Kbps channels (SCPC/PSK) to a 960-channel supergroup of voice channels. This mode would also carry teleconferenced video channels, typically four carriers to a transponder, each having a data rate of 6.4 Mbps and occupying a 4-MHz channel.

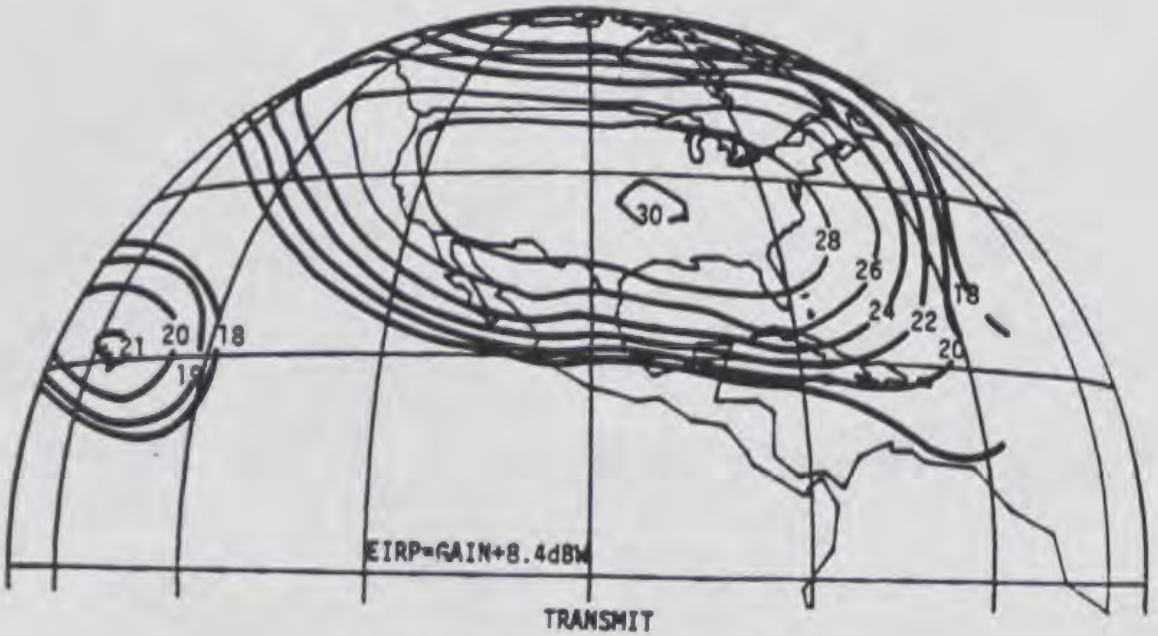
The traffic capacity of the transponder in SCPC operation is significantly increased by taking advantage of the increased linearity of the solid-state final amplifiers utilized in this satellite, as compared with traditional traveling wave tubes.

The horizontal and vertical polarization patterns of the satellite antenna gain contours are provided in Figures 6 through 9 for the two requested orbital locations of 101° W.L. and 93° W.L.



RECEIVE

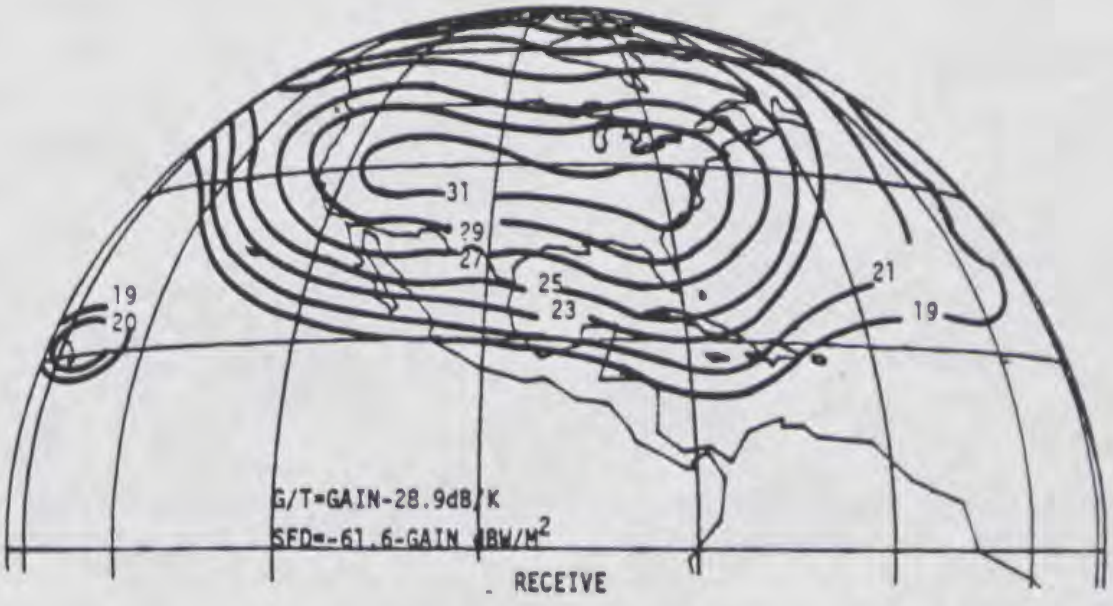
HORIZONTAL GAIN CONTOURS (101° WEST)



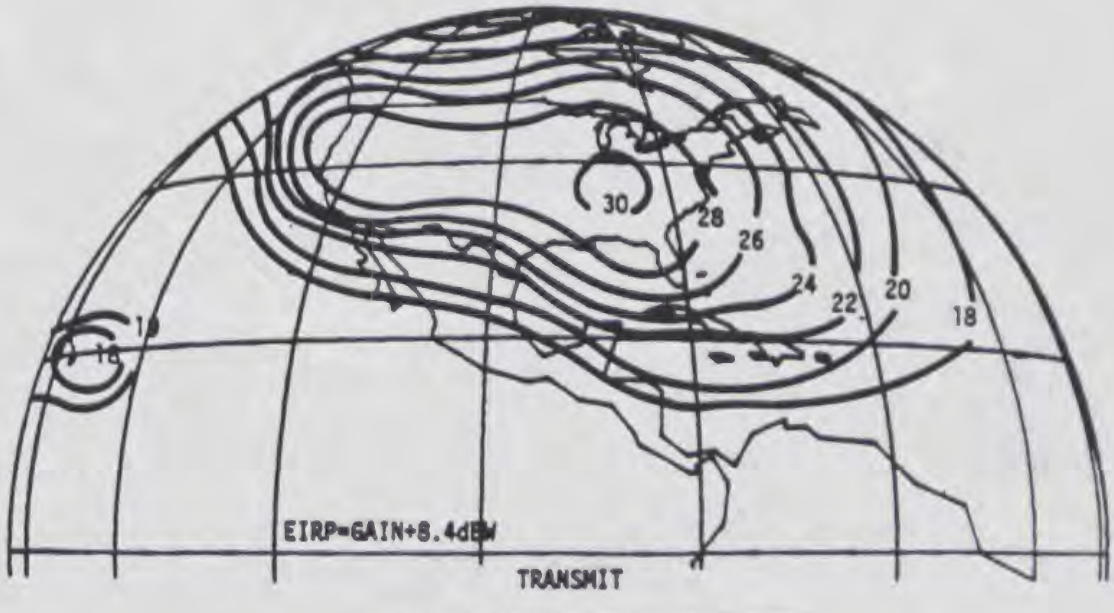
TRANSMIT

HORIZONTAL GAIN CONTOURS (101° WEST)

Figure 6 Horizontal Gain Countours (101° W.L.)

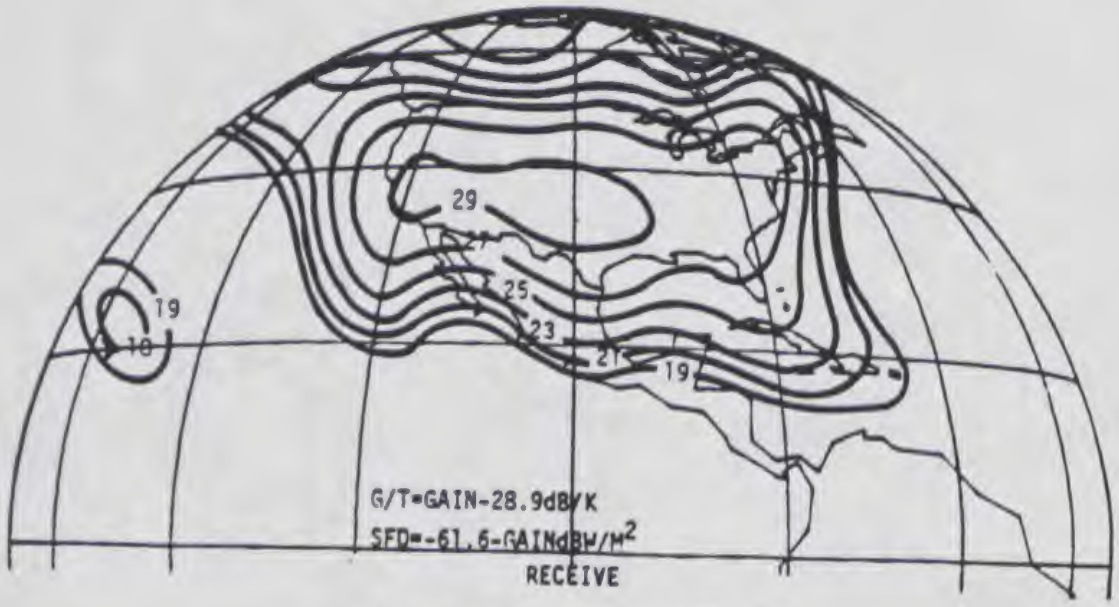


HORIZONTAL GAIN CONTOURS (93° WEST)



HORIZONTAL GAIN CONTOURS (93° WEST)

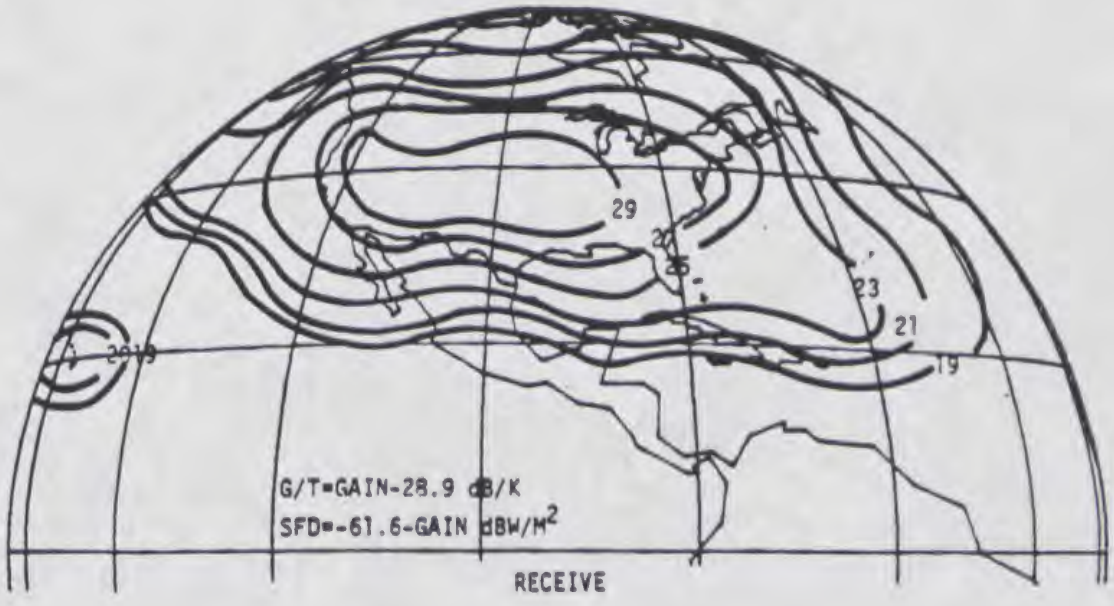
Figure 7 Horizontal Gain Countours (93° W.L.)



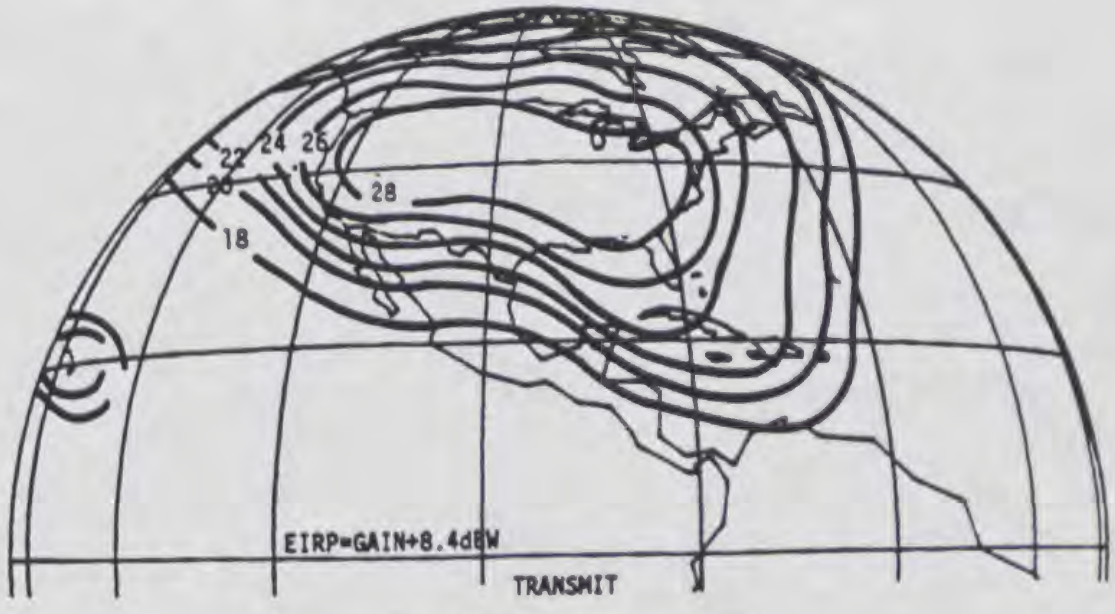
VERTICAL GAIN CONTOURS (101° WEST)

VERTICAL GAIN CONTOURS (101° WEST)

Figure 8 Vertical Gain Countours (101° W.L.)



VERTICAL GAIN CONTOURS (93° WEST)



VERTICAL GAIN CONTOURS (93° WEST)

Figure 9 Vertical Gain Countours (93° W.L.)

2. Calculations of Power Flux Density Levels Within Each Coverage Area and Energy Dispersal Needed for Compliance with Section 25.208.

The power flux density limits specified in Section 25.208 of the Commission's rules do not apply to the 11.7 - 12.2-GHz band. The following relates to the 3.7 - 4.2-GHz band.

Using the satellite antenna contours described in Figures 6 through 9 and power input to the satellite antenna for the TV/FM mode, and assuming a spreading loss of 162.5 dB from the satellite to the antenna boresight, the power flux density will be -127.1 dBW per square meter at the edge of the coverage, and -124.1 dBW at the boresight. Assuming that the worst energy concentration results from an unmodulated TV/FM carrier with artificial energy dispersal of 2 MHz, the maximum power flux density per square meter in any 4-KHz band will be -154.1 dBW per square meter at the edge of coverage, and -151.1 dBW at the antenna boresight. These values are derived from the horizontal transmit antenna pattern, which has a maximum boresight gain of 30 dB. The more critical values are at the edge of coverage, where, particularly in the northern and northeastern areas, the satellite elevation angle from a terrestrial microwave station will be on the order of 5°. The value of -154.1 dBW m^2/4KHz in this case is still 2 dB below the limit given in the ITU radio regulations and in the FCC implementation thereof. In summary, it is NEX's intention to maintain PFD at or below -152 dBW/m^2/4KHz, especially where the

station elevation angle would be less than 5° to the satellite from a fixed terrestrial station.

Coverage of Puerto Rico, the Virgin Islands, Hawaii, and portions of Alaska involves power flux densities several dB below those given for the continental United States (nominally, -159 $dBW/m^2/4KHz$ for Alaska, -162 $dBW/m^2/4KHz$ for Hawaii, and -161 $dBW/m^2/4KHz$ for Puerto Rico/Virgin Islands). In those areas, SpotNet users will utilize earth terminals with correspondingly better G/Ts to maintain optimal levels of service.

3. Number of Satellites.

The space segment of the SpotNet satellite system will consist of three hybrid satellites and two launch vehicles. Two of the satellites will be placed in orbit, while the third will serve as a ground spare to be launched in the event of failure or degradation of one of the operational satellites.

4. Estimated Number and Geographic Distribution of Earth Stations.

The vast majority of the SpotNet Ku-Band earth stations will be located on the premises of NEX's customers, and distributed at sites throughout the United States. The exact number will be a factor of market demand.

NEX estimates the capacity of the Ku-Band segment of the payload as 50,000 full duplex calls among a network of as many as 12,000 medium-scale two-way terminals, with a concurrently operative sub-network of some 100,000 small data terminals, also transmit/receive.

NEX plans to construct a number of 4/6-GHz two-way earth stations for customer use, which will be the subject of a subsequent application. Numerous additional satellite ground facilities will be located on customer premises, the exact number to be a factor of market demand. A number of the earth stations will be equipped for both 4/6-GHz and 12/14-GHz operation.

The majority of SpotNet C-Band receive-only earth stations will be located on customer premises, the exact number to be determined by market demand.

5. Physical Characteristics of the Space Stations.

NEX proposes to launch two SpotNet satellites with capabilities that are essentially identical. A third satellite will be held as a ground spare. The communications payload of each satellite will consist of eighteen transmitters and receivers operating in the 12/14 GHz system and 24 transponders in the 4/6 GHz system. NEX plans to use an existing satellite bus, such as a Hughes spin-stabilized HS-393 or an RCA three-axis stabilized RCA-S-5000, with the final choice of satellite type, satellite manufacturer and launch system to be made during the procurement process.

The SpotNet satellites will be designed to maintain the inclination of the orbit to ± 0.05 degrees or less, and the longitude position within ± 0.05 degrees. The antenna-pointing accuracy for all satellites will be maintained within ± 0.05 degrees.

The electrical power subsystem will be designed so that at the end of the spacecraft life, sufficient power will be available to operate all active transponder channels and the housekeeping loads. Sufficient battery capacity will be provided to deliver power for all housekeeping functions, and approximately half-power for the transponders during the eclipse periods at the end of the satellite's useful life.

The primary source of power will be solar cells with energy-storage batteries for eclipse operation. No single failure in the electrical energy system will cause spacecraft failure. The following Table 1 provides further details.

Table 1
Operational Satellite Characteristics

Parameter	Type or Value	
Launch vehicle	Domestic ELV, Ariane or Long March	
Launch date	See Schedule	
Satellite mission life/ design life	10 years	
North-south stationkeeping accuracy	0.05°	
East-west stationkeeping accuracy	0.05°	
Eclipse capability	100%	
Stabilization	Spin or 3-axis stabilized	
RF output power	Ku-Band:	3 @ 10 watts 4 @ 15 watts 1 @ 20 watts 2 @ 30 watts 1 @ 50 watts 4 @ 75 watts 3 @ 120 watts
	C-Band:	24 @ 9 watts
Communications channelization	Ku-Band:	9 "Spots" @ 250 MHz 9 "Beams" @ 167 MHz
	C-Band:	24 transponders @ 36 MHz
Communications EIRP	Ku-Band:	9 "Spots" @ 63 dBW/250 MHz 6 "Beams" @ 61 dBW/167 MHz 3 "Beams" @ 60 dBW/167 MHz
	C-Band:	CONUS, 34 dBW Alaska, 30 dBW Hawaii, 27 dBW Puerto Rico, 28 dBW
Communications Receive G/T	Ku-Band:	3 western "Beams" at +5 dB/K; other patterns from +8 to +19 dB/K
	C-Band:	CONUS at -5.9 dB/°K Alaska at -8.4 dB/°K Hawaii at -10.4 dB/°K Puerto Rico at -10.0dB/°K
Communications Receive SFD	C-Band:	-89.9 to -96.9 dBW/m^2
	Ku-Band:	No direct equivalent parameter; uplink power is controlled to a level of -110 dBW/m^2 (or less) per 1.5 MHz channel.

12/14-GHz communications frequencies:		
Transmit	11.700 to 12.200 GHz	
Receive	14.000 to 14.500 GHz	
4/6-GHz communications frequencies:		
Transmit	3.700 to 4.200 GHz	
Receive	5.925 to 6.425 GHz	
TT&C EIRP	To be determined (TBD)	
TT&C Receive flux density	TBD	
TT&C frequencies:		
Telemetry	TBD	
Command	TBD	
Communications polarization:	Ku-Band:	9 "Spot" patterns horizontal on uplink and downlink; 9 "Beams" patterns vertical on uplink and downlink
	C-Band:	12 transponders with vertical uplink and horizontal downlink, 12 transponders with horizontal uplink and vertical downlink
TT&C polarization		
Telemetry	TBD	
Command	TBD	

a. Weight and Dimensions of Spacecraft.

The weight and dimensions of the spacecraft will be provided to the Commission after selection of a spacecraft vendor.

b. Estimated Operational Lifetime of Space Stations.

Each SpotNet satellite will be designed for an on-orbit minimum mission life of 10 years. These goals will be achieved by careful evaluation of the effects of the space environment on the solar array, the effects of charge and discharge cycling on the satellite batteries, and wear-out characteristics of the primary and spare SSPAs and TWTAs. Materials and processes will be selected so that aging or wearing effects will not adversely affect spacecraft performance over the estimated life. A complete failure mode and effects analysis will be required of the spacecraft manufacturer, and both active and passive redundancy will be employed to assure that the objectives are met. Further assurance of obtaining the useful life and reliability goals will be achieved by relying upon space-proven hardware.

The propulsion subsystem will be sized for and loaded with sufficient propellant to maintain operational attitude and station-keeping control for at least 10 years. Additional propellant will also be incorporated to provide correction of the initial orbit, initial attitude acquisition, satellite spin or despin as required, and for limited orbital repositioning.

Sufficient propellant will also be reserved for removing the spacecraft from orbit after its mission is complete.

6. Systems Reliability, Redundancy and Link Availability.

A single SpotNet satellite system link consists of the earth station transmitting chain, including the encoder and modulator, the uplink path, the satellite itself, the downlink path and receiving earth station, and the associated control equipment. The overall availability of each link is enhanced by: (1) the two-satellite, two-orbit-location system; (2) the multiple-spot-beam coverage; (3) designing the system to permit very small earth stations; (4) designing earth stations that can access any uplink channel; (5) incorporating both active and passive redundancy into the SpotNet satellite; and (6) a conservative approach to the specification of communications link performance. The overall availability of each link, in addition, is enhanced by simultaneous operation of the SpotNet C-Band and Ku-Band subsystems.

Since outages can also result from failure of the power and attitude control subsystems of the satellite, active redundancy and standby redundancy will respectively, be employed in these critical subsystems. Two orbital positions are necessary to permit continued system use during eclipse and solar outage. Eclipse and solar noise outage periods will be computed by NEX, and customers with access to only one orbital position will be notified well in advance of the anticipated outage times. Because

NEX does not anticipate significant usage during eclipse periods, on-board battery capacity will be provided to power all required spacecraft functions, but for only reduced transponder power levels. Customers who require uninterrupted service during eclipse and solar noise outage periods can obtain such protection through the installation of dual antenna systems looking at both satellites.

Protection from outages due to heavy rainfall can be achieved by application of space-frequency diversity principles in any area. Such diversity is made economically possible by the small earth stations employed, as well as by the superior efficiency with which the SpotNet satellite system employs the geostationary orbit.

The SpotNet satellites will be designed for an operational and mission life of 10 years, a factor determined primarily by the amount of station-keeping propellant that is carried and the accuracy of orbit injection. The reliability of the Ku-Band electronics power amplifiers is such that a high probability of continuous acceptable performance of all eighteen Ku-Band patterns is assured over the lifespan of the SpotNet satellite. Use of SSPA technology with redundant final amplifiers is a key component of the SpotNet Ku-Band reliability strategy, as is the wide use of common filtering components in the Ku-Band switching facility. Similarly, the C-Band transponder configuration provides a high degree of reliability by means of a 30-for-24 TWTA redundancy.

Life and reliability of the other components and subsystems will be maximized by using space-proven hardware.

The ground segment TT&C equipment will also employ standard designs of proven reliability, with proven fail-safe capabilities and equipment redundancy to ensure a high level of availability. The use of two widely separated TT&C stations, as described earlier, will further add to system reliability and orbit determination.

7. Vehicle and Arrangements for Procuring Launch Services.

The SpotNet satellites will be compatible with a launch by a domestic ELV, Ariane, or the Long March. Each launch vehicle alternative has distinct advantages and disadvantages, and the final selection will depend upon reliability, scheduling availability, cost, and spacecraft configuration trade-offs.

Launch support arrangements have not been completed, since they depend in part upon the launch vehicle chosen, exact scheduling, and other factors. During the launch phase, TT&C facilities may be leased throughout the United States and other parts of the world. After positioning into the geostationary orbit, the TT&C functions will be accomplished from appropriate facilities.

8. Arrangements for Tracking, Telemetry and Control.

The ground segment of the SpotNet system will include a primary TT&C/NCC facility to be located on the East Coast, and a secondary or backup facility to be located on the West Coast. Each TT&C station will include two 5.5-meter-diameter antennas, operating at 12/14 GHz. These facilities will be staffed around the clock, and will have the responsibility for assuring proper operation of the satellites using the tracking, monitoring, rangefinding and command functions associated with the TT&C system. They will also have the responsibilities associated with the allocation, assignment, and adjustment of SpotNet communications capacity and characteristics. These ground segment facilities will employ standard, proven, reliable designs, with proven fail-safe capabilities and equipment redundancy to ensure a high level of availability.

E. Communication System Characteristics and Description.

1. Types of Services to be Provided, Estimated Demand for Such Services, and Areas and Entities to be Served.

NEX proposes to provide two basic services -- described herein as a "medium" and a "small" network -- via its Ku-Band satellite system. Other special services also could be provided.

In the medium network, each station will be able to achieve full mesh interconnectivity, with all medium network terminals served by a single satellite, using frequency agility and multi-

carrier TDMA/FDMA access methods. The TDMA burst rate is presently planned to be approximately 1,200 kilosymbols/second and is based on a traffic quantum of 32 Kbps per entry (or slot) with 50 slots per TDMA frame. Each medium station has the capability to have 24 slots active concurrently, representing a full T-1 loading of independently targeted calls; larger stations could also be accommodated. TDMA channels are located on nominal 1.5 MHz centers with a total of 324 such channels being formed from the 500 MHz bandwidth available at Ku-Band. With the 7.5 frequency reuse, this yields a total of 2,430 such TDMA channels with over 100,000 slots.

These slots provide a general omnibus digital connection for the transport of speech, electronic mail, video conferencing, computer-aided design/manufacturing, and other forms of information transfer for which full network switchability is essential.

In the small network, large sets of very small aperture stations are organized in a star configuration with a central hub. The small sub-networks use TDM out-routes and sub-channel TDMA in-routes as are typically found in VSAT architectures. These sub-channels are derived by dividing a medium network channel into five parts with an occupied bandwidth of 300 KHz per sub-channel. The transmission rate in the small network is 240 kilosymbols/second. NEX has optimized the SpotNet small network for

applications such as point-of-sale terminals where the traffic is bursty and the average data rate is low.

The SpotNet C-Band system will be capable of providing the following services: broadcast video and audio, teleconferencing, FDM/FM multichannel telephony, SCPC audio and text, and SCPC telephony. In the provision of such services, all 24 C-Band transponders will be available.

2. Transmission Characteristics, Modulation Parameters, and Performance Objectives.

a. Ku-Band.

Typical use of the SpotNet Ku-Band system will be activities in the small or medium network described supra. NEX has concluded since the filing of its 1983 application that a "large" (e.g., 45 Mbps) network is not a feasible part of the Ku-Band SpotNet offering, and service of this type is, therefore, no longer proposed for the Ku-Band payload.) Performance objectives for these services are shown in Table 2; key transmission parameters are summarized in Table 3.

Table 2

Overall Ku-Band Link Availability Due to Weather

Network	Objective
"Small"	BER no worse than 10^{-6} for 99.5% of time
"Medium"	BER no worse than 10^{-6} for 99.5% of time

Table 3

Typical Ku-Band Earth Station Parameters

Parameter	Medium Network	Small Network
Bandwidths of channel centers	1500 KHz	300 KHz
Access methods	TDMA/FDMA	TDM/FDMA (out) TDMA/FDMA (in)
Frequency accessibility	Agile to all channels in up & downlinks	Fixed
Network topology	Mesh	Star
Transmission speed	1200 Ksym/sec	240 Ksym/sec
Modulation form	QPSK	BPSK
Convolutional code rate and constraint length	3/4 45	1/2 36
Decoding method	Sequential	Sequential
Net thruput/channel	1536 Kbps	96 Kbps
Frame efficiency	0.667 bits/dim.	0.400 bits/dim.
Antenna	1.8 meter	1.2 meter
HPA rating	2.0 watts (4.0 watts in western beams)	0.5 watts
LNA rating	250°K	300°K
Features	Uplink power control	* * * *

b. C-Band.

For broadcast video, each C-Band transponder will be capable of handling a single video channel and associated audio channels. A number of additional audio or digital subcarriers can also be carried in such a configuration. The total number of subcarriers depends on the power assigned to each carrier. Techniques to further expand the useful transmission capabilities of each transponder for multichannel and high-definition video are being explored using coding schemes and advanced digital modulation techniques.

NEX presently plans to carry four video teleconferencing channels per transponder. A full complement of 960 FDM/FM multiplex telephony channels will be carried on the transponders designated for that purpose. Because of the increased linearity of the solid-state final amplifiers in this design, NEX anticipates that more than 60 SCPC program audio channels (plus additional text channels) can be carried per transponder. In the case of SCPC telephony, approximately 1,600 SCPC telephony channels can be accommodated in a single transponder. NEX will be able to carry approximately 720 56-Kbps digital channels per transponder.

Overall C-Band link performance objectives are given in Table 4.

Table 4

Overall C-Band Communications Performance Objectives

Video	
Broadcast Quality Video	55 dB p-p signal-to-weighted-rms-noise ratio
TVRO Video	50 dB p-p signal-to-weighted-rms-noise ratio
Video Teleconference	10^{-6} BER
Telephony	
FDM/FM Telephony	50 dB weighted test-tone-to-noise ratio
SCPC/FM Telephony	35 dB test-tone-to-weighted-rms-noise ratio (uncompanded)

In the case of telephony, the calculations are governed primarily by the noise objective for an individual telephone channel, pursuant to CCIR Recommendation 353-2. The standard objective of 10,000 pWop is divided as follows:

Ground station equipment . . . . . 1,000 pWop

Ground station interference. . . . . 500 pWop

Satellite interference . . . . . 1,000 pWop

Satellite thermal. . . . . 7,500 pWop

For a single carrier having 960 telephone channels, the weighted test-tone-to-noise per channel is 7,328 pWop. The additional noise due to two adjacent overlapping cross-polarized channels is less than 10 pWop. The total intrasystem noise is therefore below the value of 7,500 pWop given above.

For full-bandwidth C-Band video transmission, NEX plans to employ a 10-meter uplink terminal and either 10-meter or 4.5-meter receive terminals. The link power budgets for both of those cases are shown in Table 5.

Table 5

Communications Link Budget - Video

Uplink, 6,175 MHz	
Transmitter EIRP	78.0 dBW
Path loss	- 200.1 dB
Other losses	- 0.3 dB
Satellite G/T (for hor. pol.)	- 4.0 dB/K
Boltzman's constant	- 228.6 dB/K Hz
C/N per hz.	102.2 dB-Hz
C/N_{uplink}	26.6 dB
Downlink, 4,000 MHz for 10-meter receive antenna	
Satellite EIRP at CONUS beam edge	34.0 dBW
Path loss	- 196.5 dB
Other losses	- 0.3 dB
Receive station antenna gain	50.7 dB
Receive carrier power	- 112.1 dBW
Boltzman's constant	- 228.6 dB/K-Hz
LNA temperature (125° K)	21.0 dbK
Received noise power	- 207.6 dBW/Hz
C/N per hz	95.5 db-Hz
C/N downlink	19.9 dB
C/N_{total}	19.0 dB
Downlink, 4,000 MHz for 4.5-meter receive antenna	
Satellite EIRP at CONUS beam edge	34.0 dBW
Path loss	- 196.5 dB
Other losses	- 0.6 dB
Receive station antenna gain	44.0 dB
Receive carrier power	- 119.9 dBW
Boltzman's constant	- 228.6 dB/K-Hz
LNA temperature (125° K)	21.0 dBK
Received noise power	- 207.6 dBW/Hz
C/N per hz.	88.5 db-Hz
C/N downlink	12.9 dB
C/N_{total}	12.6 dB

For teleconferencing, NEX plans to transmit four teleconference video channels in each transponder assigned to that service, each employing time-division-multiplex techniques. Bit rates will be 6.4 Mbps per channel, and the bit energy-to-noise ratio of 13 dB will ensure a BER (bit-error-rate) of less than 10^{-6} for coherent QPSK. Summary information on this link is contained in Table 6.

Table 6

Communications Link Budget - Teleconferencing

Uplink at 6,175 MHz	
Transmitter EIRP	65.0 dBW
Path loss	- 200.0 dBW
Other losses	- 0.3 dB
Satellite G/T (for hor. pol.)	- 4.0 db/K
Bit rate, B (6.4 MBS)	68.1 db-Hz
C/N up per channel	21.2 dB
Downlink at 4,000 MHz for 10-meter antenna	
Satellite EIRP	34.0 dBW
SSPA backoff	- 2.3 dB
Number of video channels	- 6.0 dB
Path loss	- 196.0 dB
Other losses	- 0.2 dB
Earth station antenna gain	50.7 dB
Received carrier power	- 119.5 dBW
Received noise power	- 207.6 dBW/Hz
Bit rate, B	68.1 db-Hz
Noise power for bit rate B	- 139.1 dBW
$C/N_{downlink}$	19.6 dB
C/N_{uplink}	21.2 dB
$C/N_{intermod}$	16.0 dB
C/N_{total}	13.4 dB

For SCPC telephony, each of the SCPC carriers will be voice-activated and will frequency-modulate their carriers. The voice baseband will be pre-emphasized and companded. Major link parameters for this mode are given in Table 7.

Table 7

Communications Link Budget - SCPC Telephony

Uplink for 10 meter antenna (6,170 MHz)		
Transmitter EIRP	78.0	dBW
Number of carriers - 1600	- 32.0	dB
Voice activation	+ 4.0	dB
Input backoff	- 7.0	dB
EIRP per voice channel	45.0	dB
Path loss	- 200.0	dB
Satellite G/T (for hor. pol.)	- 4.0	dB
C/T uplink	- 161.0	dBW/K
C/N uplink	67.6	dB-Hz
Channel bandwidth (20 KHz)	43.0	dB-Hz
C/N total uplink	24.6	dB
Number of carriers for 4.5 m. antenna is 1000	- 30.0	dB
C/N total uplink for 4.5 m. antenna system	26.6	dB
Downlink for 10 meter antenna (4,000 MHz)		
Satellite EIRP	34.0	dBW
Power split	- 32.0	dB
SSPA backoff	2.3	dB
Voice activation gain	+ 4.0	dB
Path loss	- 196.0	dB
Antenna gain (10 meters)	50.7	dB
Loss due to tracking error	0.2	dB
Received carrier power	- 143.8	dBW
Boltzman's constant	- 228.6	dBW/K-Hz
Receive bandwidth (20 KHz)	43.0	dB-Hz
Receiver noise temperature (125° K)	21.0	dBK
Noise power received	164.6	dBW
C/N downlink	22.8	dB
C/N intermod	16.0	dB
C/N uplink	24.6	dB
C/N total	14.7	dB
Margin above threshold	7.0	dB
Downlink for 4.5 meter antenna (noting items changed only)		
Power split	30.0	dB
Antenna gain (4.5 meters)	44.0	dB
Loss due to tracking error	- 0.5	dB
Received carrier power	- 148.8	dBW
C/N downlink	17.8	dB
C/N uplink	26.6	dB
C/N total	13.6	dB

3. Space Communications Subsystem.

The Ku-Band payload, as presently conceived, is diagrammed in Figure 2, supra. Each uplink pattern is intercepted by SpotNet's large antenna and is served by a dedicated set of feed horns which determine its characteristic coverage pattern.

After initial amplification at 14 GHz, the broadband signals from each pattern (which typically include up to 108 or 162 channels of nominal T-1 TDMA) are downconverted to a common intermediate frequency, resulting in the spectrum for each pattern having its lower edge referenced to 2500 MHz. (This figure is representative and is used to facilitate discussion: the actual value of the IF frequency will be determined during the detailed spacecraft design.)

A major innovation contained in the SpotNet Ku-Band payload is the use of frequency sensitive switching through the satellite. In the present configuration, each of the eighteen downlink patterns is accessible from each of the eighteen uplink patterns as a consequence of each uplink being separated into eighteen distinct parts, as illustrated in the block labelled "FILTERS" in Figure 2. Following the separation of the uplinks into inter-pattern spectra, the resultant IF signals are routed to the downlink electronics by means of the cross patch. Each of the eighteen downlink patterns is formed as the sum of eighteen of these signals, one each from filtered outputs of the eighteen uplink patterns. NEX has devised an arrangement of the inter-pattern

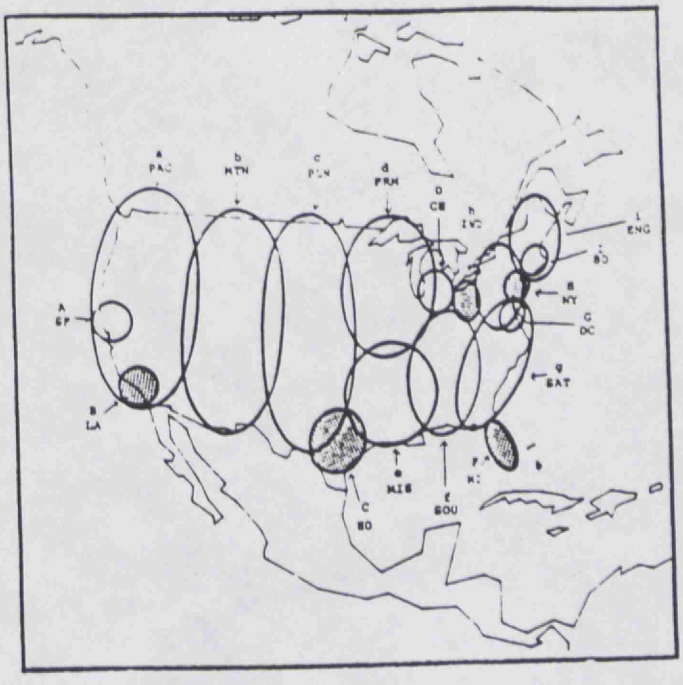
frequency allocations for the uplinks such that the cross patch signals can be simply added together to form the various downlink patterns. As a result of this scheme, which is known as "permutation routing," no conflicts arise in the placement of spectral components in the pattern's downlink process and no unusable gaps exist in the downlink bandwidth. The downlink spectra are next re-translated to Ku-Band. Five different downlink spectra types are formed in this up-conversion, corresponding to the regions shown in Figure 10, infra.

The final amplifiers for each of the downlink patterns have a power rating which varies inversely with the antenna gain for the pattern and directly with the bandwidth allocated to the pattern. As a consequence, the resultant EIRP per Hertz is essentially constant across the patterns so that a similar quality of service is provided by the SpotNet Ku-Band payload to all geographic regions. An exception to this occurs in the western three beams. Because of the large relative size of these beams, and because of the reduced incidence of rain fading in these regions, NEX has elected to reduce the EIRP by one dB for these three cases.

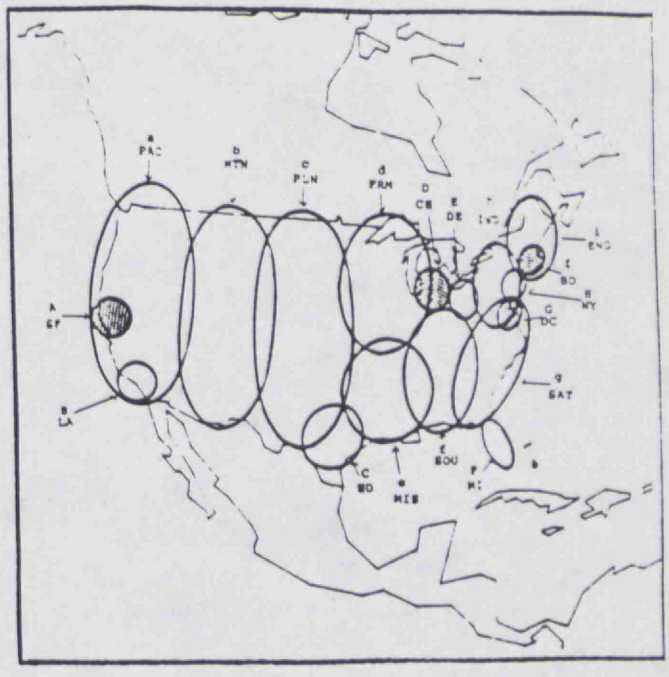
The SpotNet Ku-Band final amplifiers will always be operated with ample back-off from their saturation points. The smaller amplifiers will be SSPAs, while the higher power amplifiers may be paralleled SSPAs, or backed-off TWTAs, to achieve the necessary combination of linearity, power, and efficiency.

The geographic coverage patterns of the downlink are formed using a large, 4.2 meter aperture antenna. This large antenna, when illuminated via the complex feed system of the SpotNet Ku-Band downlink, permits spot patterns of small radius to be formed over dense traffic areas, such as the urban Northeast, and also has the flexibility to provide the various larger coverage patterns required by SpotNet.

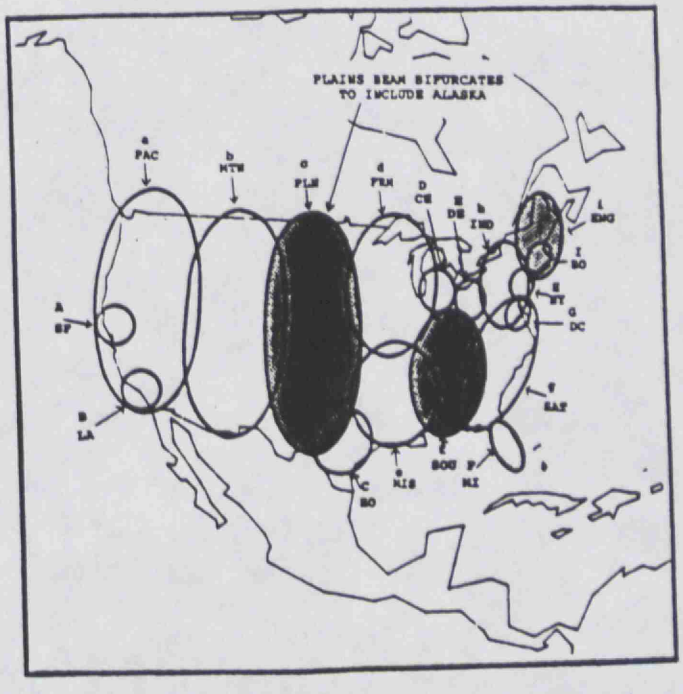
Both uplink and downlink antenna patterns for the SpotNet Ku-Band payload will be designed with careful attention to isolation between orthogonally polarized patterns and between spatially separated pairs of patterns that employ the same frequency and polarization. Design goals, which studies have confirmed to be achievable, are for no less than 30 dB of polarization isolation and 24 dB of spatial isolation. A set of five figures depicting the spatial relation among the patterns with frequency/polarization reuse appears at Figure 10. The SpotNet Ku-Band communication performance is summarized in Table 8.



(A) REUSE OF HORIZONTAL - LOWER 250 MHz
(SPOTS B, C, E, F, H)

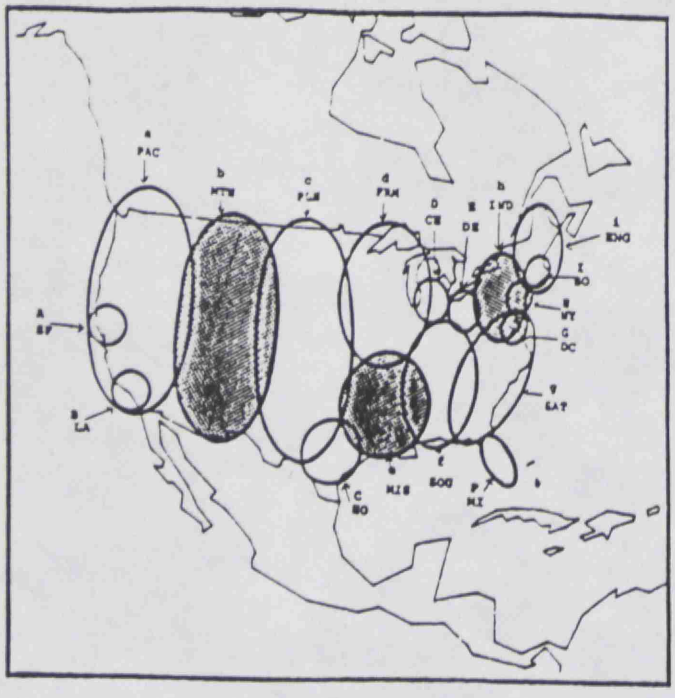


(B) REUSE OF HORIZONTAL - UPPER 250 MHz
(SPOTS A, D, G, I)

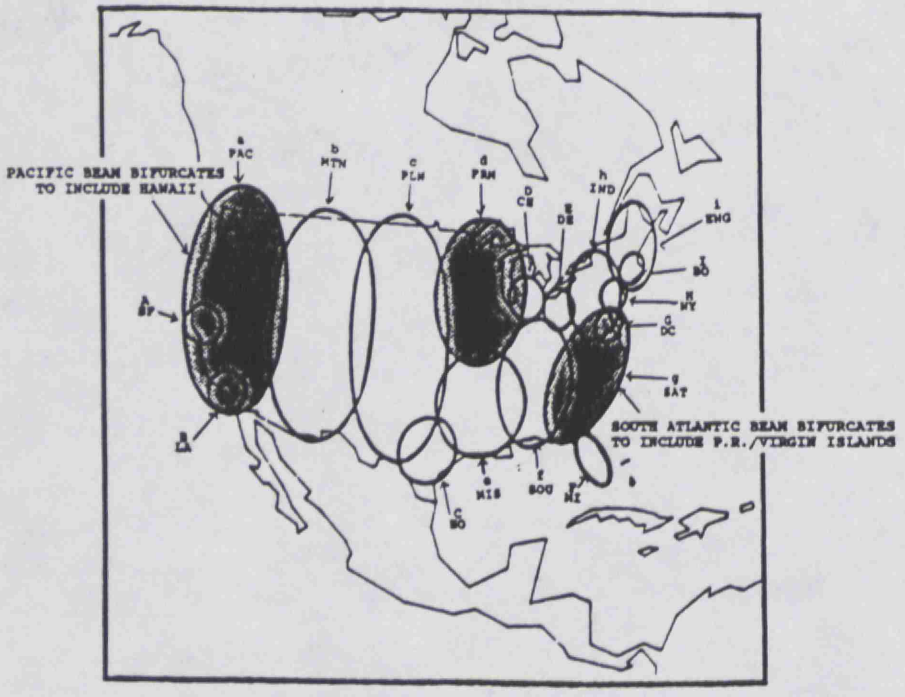


(C) REUSE OF VERTICAL - MIDDLE 167 MHz
(BEAMS c, f, i)

Figure 10. Ku-Band Patterns at 101° W.L.
(1 of 2)



(D) REUSE OF VERTICAL - MIDDLE 167 MHz
(BEAMS b, e, h)



(E) REUSE OF VERTICAL - LOWER 167 MHz
(BEAMS a, d, g)

Figure 10. Ku-Band Patterns at 101° W.L.
(2 of 2)

Table 8

Summary of SpotNet Ku-Band Communication Performance

Uplink antenna gains (boresight)	40 to 54 dBi
System Temperature	1000°K
Figure of merit (edge of coverage)	+5 dB/K or better
Downlink antenna gains (edge of coverage)	35 to 47 dBi
HPA ratings	10 to 125 watts
Total RF power	880 watts
EIRPs (edge of coverage)	56 to 59 dBW
Design EIRP per T-1 equivalent channel (edge of coverage)	36 dBW (downlink) 49 dBW (uplink) 52 dBW (western beam uplinks)
Gain controls	18 up and 18 down -5 dB to +5 dB by 0.5 dB
Isolation	30 dB cross polarization 24 dB nearest patterns with same polarization and frequency.

4. Typical or Baseline Earth Station Characteristics.

Table 9 provides the primary transmission characteristics for the "small" and "medium" Ku-band network stations. The medium network stations have a peak capacity of 1536 Kbps, an antenna aperture of 1.8 meters, a final amplifier rated at 2.0 watts (the amplifier rating is increased to 4.0 watts for the Pacific, Mountain, and Plains patterns (beams a, b, and c in Figure 10),

which yields an EIRP of 49 dBW (52 dBW in beams a, b, and c). Under clear sky conditions, the medium network stations use a reduced power that is 2 dB below these rated values. The additional power is held in reserve to compensate for uplink rain fading and may be adjusted upward in increments of 0.5 dB, as required. The figure-of-merit for an earth station in the medium network is 20.2 dB/K. Medium network stations have full frequency agility and may access any T-1 channel in the uplink and downlink frequencies serving the station's pattern.

The small network stations have a peak capacity of 96 Kbps, an antenna aperture of 1.2 meters, and an HPA of 0.5 watts, resulting in an inroute EIRP of 39.4 dBW. The figure-of-merit of a small network station is 16.5 dB/K with an out-route downlink EIRP of 29.0 dBW per subcarrier being provided. Small network hub earth stations have 3.0-meter antenna apertures with corresponding transmit and receive antenna gains of 50.3 and 49.0 dBi, respectively.

Table 9

Typical Earth Station Characteristics

Parameter	Medium	Small	Hub	
Uplink antenna gain (boresight)	46.6	42.9	50.3	dBi
Clear sky uplink EIRP	47.0/50.0	39.4	40.0/43.0	dBW
Reserve for uplink power control	2.0	N/A	2.0	dB
Downlink antenna gain (boresight)	45.0	41.7	49.0	dBi
Figure of merit	20.0	16.5	23.8	dB/K

NOTE: EIRP figures are actual as opposed to rated values and larger EIRP figures apply to stations located in western beams (a, b, & c).

5. Link Budget and Overall Performance Analysis.

Link equations for SpotNet Ku-band service using the "medium" and the "small" networks have been developed and are presented in this section. These analyses assume earth stations in the three western beams (a, b, and c of Figure 10); for earth stations located in all other patterns, slightly better performance may be expected due to the higher G/T and EIRP per carrier for those patterns. To be conservative, the earth stations in the analysis are assumed to be at the edge of coverage of the patterns. Note, however, that earth stations situated at points of higher gain within a pattern's coverage will have their uplink power adjusted such that, under clear sky conditions, the received signal levels in the various slots of a T-1 equivalent carrier will appear

essentially equal at the satellite, regardless of the earth station's site within the coverage pattern. This strategy is used by NEX to ensure that the downlink power developed by SpotNet does not fluctuate markedly due to variations in the origin of the traffic load.

a. Medium Network Service.

The bulk of the Ku-band traffic handled by the SpotNet satellite will use the "medium" network transmission method. This involves the division of the spectrum into numerous T-1 equivalent channels, each assigned a band of 1.5 MHz, of which 1.2 MHz is occupied within the half-power points of the spectrum. Each such channel is used in a fully synchronized TDMA format, with a burst rate of 1,200 QPSK symbols per second and a 45 millisecond frame organized into 50 slots, each of 900 microseconds duration. Medium network earth stations are assigned capacity in terms of channels and slots by the NCC. Each such channel slot assignment constitutes a capacity unit of 32 Kbps, which may be used for digital voice, in-band data, or combined into multiple slots for teleconferencing, digital fax, etc.

The link budgets for medium network transmission are exhibited at Tables 10 and 11. The PA rating of 6.0 dBW applies only to the three "beam" patterns west of the Mississippi. All other medium network stations (approximately 90% of the earth stations) are amply powered with a 3.0 dBW final amplifier, due to the superior figure-of-merit present in patterns with a smaller

coverage. Calculations performed by NEX revealed, however, that the benefits of higher uplink G/T in combatting uplink thermal noise reach a point of diminishing returns around +10 dB/K, due to adjacent system interference effects. Thus, NEX proposes to use the same uplink EIRP of 49 dBW (including a dB uplink fade power reserve) for all fifteen patterns other than the Western beams (a, b, and c from Figure 10), which, as shown in Table 10, have 52 dBW.

Table 10

Medium Network Uplink Budget

Frequency	14.0	GHz	
PA	6.0	dBW	(4 watts)
Earth Station OBO	0.0	dBW	
Line Loss	0.5	dB	
Antenna Gain (1.8 M)	46.6	dBi	Efficiency = 0.65
Antenna Pointing Loss	0.1	dB	
Earth Station EIRP	52.0	dBW	
Path Loss	207.5	dB	EL = 20°
Rain Loss	2.0	dB	99.5% availability
*Spacecraft G/T	5.0	dB/°K	edge of coverage
Uplink C/T	-152.5	dB/°K	
Boltzmann's Constant	-228.6	dB/°K-Hz	
Uplink C/N_o	76.1	dBHz	
Burst Rate (1.2 msps)	60.8	dBHz	
Uplink $C/N = C/N_o - 10 \log 1.2$ MHz	15.3	dB	
Uplink C/I	14.1	dB	
Uplink C/B	11.7	dB	

C/N - Carrier to (thermal) noise ratio
C/I - Carrier to Interference ratio
C/B - Carrier to Background (thermal plus interference) ratio

* G_{CONUS} = 28 dBi edge of coverage. Size of the west beam is 1/5 of the CONUS beam thus $G_{WEST} = G_{CONUS} + 10 \log 5 = 35$ dBi, T = 1000°K = 30 dB °K and G/T = 5 dB/°K

Table 11

Medium Network Downlink Budget

Frequency	12.0	GHz	
Spacecraft EIRP/T1	36.0	dBW	
Path Loss	205.9	dB	EL = 20°
Rain Loss	2.0	dB	99.5% availability
RX Antenna Gain	45.0	dBi	Efficiency = 0.65
System Temperature	300.0	°K	
Earth Station G/T	20.2	dBi/°K	
Antenna Pointing Loss	0.1	dB	
Downlink C/T	-151.8	dB/°K	
Boltzmann's Constant	-228.6	dB/°K-Hz	
Downlink C/N_o	76.8	dBHz	
Burst Rate (1.2 msps)	60.8	dBHz	
Downlink C/N	16.0	dB	
Downlink C/I	14.7	dB	
Downlink C/B	12.3	dB	
Uplink C/B	11.7	dB	
Link C/B	9.0	dB	
Minimum Required C/B for BER = 10^{-6}	8.9	dB	
Margin	0.1	dB	

Post HPA line losses are low (0.5 dB) in the medium network earth stations, since no post HPA filtering is employed in these terminals due to the need for full frequency agility on the uplink (to permit access to all other stations in the network). Since the earth terminals may be operated with some non-linearity, (worst case design value is for operation of the SSPA at the 1 dB gain compression point), there is a contribution to the link background due to spectrum regrowth. This effect has been included in the link analysis conducted by NEX.

An antenna efficiency of 65% is used in the analysis, which is representative of the performance anticipated for the offset feed structure proposed for the medium network earth stations. Since the SpotNet satellite will have very precise station keeping, the pointing loss for these stations is small.

The uplink EIRP of 52 dBW shown in Table 10 represents a worst case for the SpotNet medium network, due to the conservative assumptions made in the Table which include: lowest G/T uplink pattern; edge of coverage; and deployment of the uplink fading power reserve. The lowest value of uplink EIRP for a T-1 equivalent channel is 43 dBW (where the reduction of 9 dB results from a 3 dB lower rating of the uplink in most patterns), a 4 dB difference between boresight and edge of coverage, and the holding in reserve of the 2 dB uplink fading power reserve. In general, uplink EIRP is maintained, throughout the SpotNet medium network, at a level which produces a downlink EIRP of 36 dBW per T-1

equivalent channel, except under conditions where uplink fading exceeds 2.0 dB.

The remainder of the medium network uplink budget is straight forward and results in a value of C/N of 15.3 dB. Uplink interference effects include: (1) adjacent SpotNet uplink patterns; (2) cross-polarized SpotNet uplink patterns; (3) spectrum regrowth effects with SpotNet passbands; and (4) adjacent satellite interference. The combined uplink background level due to noise and interference is then 11.7 dB below the carrier.

The medium network downlink analysis in Table 11 is based on a standard downlink EIRP of 36 dBW per T-1 equivalent carrier. This power level is compensated for antenna feed losses and includes a 2 dB margin for downlink fading; the link analysis is conservatively premised on the presence of the fading. Under clear sky conditions, the downlink performance will be enhanced by the presence of the margin power. The downlink link analysis assumes that the receiving earth terminal is at the edge of coverage of the pattern. Stations more centrally located within a pattern will have a further enhancement in downlink carrier level.

The earth terminal system temperature of 300 degrees assumed in Table 11 includes contributions due to sky noise as well as thermal noise. The resultant downlink C/N of 16.0 dB due to thermal effects may be overridden by the down link carrier to interference ratio of 14.7 dB predicted by NEX's conservative downlink interference analysis. The sources of interference

included in the model included: adjacent SpotNet downlink beams; cross polarized SpotNet downlinks; intermodulation effects arising in the final amplifiers in the Ku-band SpotNet payload; and signals from adjacent satellites. The intermodulation background produced by the satellite's high power Ku-band amplifiers is based on their operation at an output back-off of 3 dB under worst case conditions.

Together, the noise and interference in the downlink result in a carrier-to-background ratio of 12.3 dB, which is of the same order of magnitude as the uplink C/B value of 11.7 dB.

The resultant composite link value for the medium network is 9.0 dB, compared to the figure of 8.9 dB that NEX believes to be a conservatively margined value for an error rate of 10^{-6}. Calculation of the 8.9 dB figure for minimum acceptable C/B is based on the use of QPSK modulation, rate 3/4 convolutional coding with sequential decoding to yield a coding gain of 5.3 dB, and an implementation margin of 1.8 dB. Within this implementation margin are contributions for phase noise, timing jitter, gain fluctuations, and other processing imperfections.

b. Small Network Service.

The SpotNet Ku-band payload will also support a small network with a star architecture which uses very small and low cost earth terminals for transaction oriented digital communications, such as point-of-sale terminals, reservation systems, etc. The small network uses sub-channels derived from the T-1 equivalent channels

described above, with each T-1 channel yielding five small channels of 300 KHz each. The small network 240 kilosymbol/second traffic occupies 240 KHz between the spectral half-power points. These small network earth stations connect with a hub station and use TDM and TDMA access on their out-routes and in-routes, respectively. The net transport rate in either direction is 96 Kbps for the small network links.

Because of the need for low cost in the small network terminals, trade-offs between efficiency and cost have generally been resolved in favor of low cost for these terminals. The impact on the overall SpotNet Ku-band efficiency is minor, however, since the percentage of traffic handled by the small network is not expected to exceed 15% of the Ku-band total.

The link budgets for the small network are displayed in Tables 12 through 15. The transmission system is asymmetric in the small network, as is frequently the case for a system of VSAT terminals, so that two distinct composite link analyses are required to define the operation of the small network. The following paragraphs provide additional explanation on the small network transmission.

Table 12

Small Network Inroute Uplink Budget

Frequency	14.0	GHz	
PA	-3.0	dBW	(0.5 watts)
Earth Station OBO	0.0	dB	
Line Loss	0.5	dB	
Antenna Gain (1.2 M)	42.9	dBi	Efficiency = 0.65
Antenna Pointing Loss	0.1	dB	
Earth Station EIRP	39.4	dBW	
Path Loss	207.5	dB	EL = 20°
Rain Loss	2.0	dB	99.5% availability
*Spacecraft G/T	5.0	dB/°K	edge of coverage
Uplink C/T	-165.1	dB/°K	
Boltzmann's Constant	-228.6	dB/°K-Hz	
Uplink C/N_o	63.5	dBHz	
Burst Rate (240 ksps)	53.8	dBHz	
Uplink C/N	9.7	dB	
Uplink C/I	8.9	dB	
Uplink C/B	6.3	dB	

* G_{CONUS} = 28 dBi edge of coverage. Size of the west beam is 1/5 of the CONUS beam thus $G_{WEST} = G_{CONUS} + 10 \log 5 = 35$ dBi, T = 1000°K = 30 dB °K and G/T = 5 dB/°K

Table 13

Small Network Inroute Downlink Budget

Frequency	12.0	GHz	
Spacecraft EIRP/Carrier	23.3	dBW	
Path Loss	205.9	dB	EL = 20°
Rain Loss	2.0	dB	99.5% availability
RX Antenna Gain (3-m)	49.0	dBi	Efficiency = 0.55
System Temperature	330.0	°K	
Earth Station G/T	23.8	dBi/°K	
Antenna Pointing Loss	0.1	dB	
Downlink C/T	-160.9	dB/°K	
Boltzmann's Constant	-228.6	dB/°K-Hz	
Downlink C/N_o	67.7	dBHz	
Burst Rate (240 ksps)	53.8	dBHz	
Downlink C/N	13.9	dB	
Downlink C/I	11.0	dB	
Downlink C/B	9.2	dB	
Uplink C/B	6.3	dB	
Link C/B	4.5	dB	
Minimum Required C/B for BER = 10^{-6}	4.3	dB	
Margin	0.2	dB	

Table 14

Small Network Outroute Uplink Budget

Frequency	14.0	GHz	
PA	0.0	dBW	(1 watt)
Earth Station OBO	4.7	dB	
Line Loss	0.5	dB	
Antenna Gain (1.8 M)	50.3	dBi	Efficiency = 0.55
Antenna Pointing Loss	0.1	dB	
Earth Station EIRP	45.0	dBW	
Path Loss	207.5	dB	EL = 20°
Rain Loss	2.0	dB	99.5% availability
*Spacecraft G/T	5.0	dB/°K	edge of coverage
Uplink C/T	-159.6	dB/°K	
Boltzmann's Constant	-228.6	dB/°K-Hz	
Uplink C/N_o	69.0	dBHz	
Burst Rate (240 ksps)	53.8	dBHz	
Uplink C/N	15.2	dB	
Uplink C/I	14.1	dB	
Uplink C/B	11.6	dB	

* G_{CONUS} = 28 dBi edge of coverage. Size of the west beam is 1/5 of the CONUS beam thus $G_{WEST} = G_{CONUS} + 10 \log 5 = 35$ dBi, T = 1000°K = 30 dB °K and G/T = 5 dB/°K

Table 15

Small Network Outroute Downlink Budget

Frequency	12.0	GHz	
Spacecraft EIRP/Carrier	29.0	dBW	
Path Loss	205.9	dB	EL = 20°
Rain Loss	2.0	dB	99.5% availability
RX Antenna Gain (1.2m)	41.7	dBi	Efficiency = 0.65
System Temperature	330.0	°K	
Earth Station G/T	16.5	dBi/°K	
Antenna Pointing Loss	0.1	dB	
Downlink C/T	-162.5	dB/°K	
Boltzmann's Constant	-228.6	dB/°K-Hz	
Downlink C/N_o	66.1	dBHz	
Burst Rate (240 ksps)	53.8	dBHz	
Downlink C/N	12.3	dB	
Downlink C/I	13.6	dB	
Downlink C/B	9.9	dB	
Uplink C/B	11.6	dB	
Link C/B	7.7	dB	
Minimum Required C/B for BER = 10^{-6}	4.3	dB	
Margin	3.4	dB	

All small network earth stations are provided with a 0.5 watt amplifier which, together with a 1.2 meter antenna, generates a 39.4 dBW in-route uplink EIRP, after accounting for various losses. This value of EIRP is adequate to power the in-route from a station at the edge of coverage in the largest patterns (beams a, b, and c in Figure 10) and with a 2.0 dB margin for in-route uplink fading. Power control is not used for the small network, since these signals constitute a small fraction of the total pattern power. For the case analyzed at Table 12, which corresponds to the Pacific beam (designated "a"), the resultant uplink C/N is 9.7 dB at the faded limit. Interference, including effects from SpotNet's own medium network, results in an in-route uplink C/I ratio of 8.9 dB, according to a conservative analysis performed by NEX. The resultant in-route uplink carrier-to-background ratio is 6.3 dB.

The small network traffic traverses the same Ku-band payload as the medium network traffic. For the signal levels set out in Table 12, the in-route downlink EIRP per subcarrier will be 23.3 dBW. In most cases the in-route downlink EIRP will be higher than this, as a result of more favorably sited uplink stations, the superior G/T of most other uplink patterns, and the absence of fading in the uplink.

The in-route downlink EIRP of 23.3 dBW includes a 2.0 dB allowance as a margin for downlink fading. When received at a hub with a G/T of 23.8 dB/K, the in-route downlink exhibits a carrier

to noise ratio of 13.9 dB. Interference effects are conservatively predicted to induce a C/I of 11.0 dB on the in-route downlink, for a carrier-to-background ratio of 9.2 dB. When combined with the uplink background, the composite link carrier-to-background noise ratio is 4.5 dB for the small network in-route, and meets its performance objective of 4.3 dB established by NEX for a bit error rate of 10^{-6} or better.

The 4.3 dB figure for in-band carrier-to-background is derived based on BPSK modulation, rate 1/2 coding with sequential decoding and a coding gain of 6.3 dB, and an impairment budget of 3.0 dB to cover phase noise, amplitude instabilities, and various other degradations from ideal performance.

The small network out-route uplink (hub-to-satellite) is designed to have the same power spectral density as the medium network (see Table 12) and hence yields the same uplink carrier to background ratio of 11.6 dB as shown in Table 14 at the faded out-route uplink limit of 2.0 dB. Power control is employed by the hub to maintain a nearly constant uplink illumination of the satellite over the fading design range of 2.0 dB, thereby avoiding excess downlink EIRP during clear sky operation.

The out-route downlink for the small network also has the same power spectral density as the medium network. (Since the symbol rate of the small network transmissions is one fifth that of the medium network, the actual EIRP is 7 dB less or 36 - 7 = 29 dBW). A 2.0 dB rain margin is built into the downlink carrier:

Table 15 cancels this margin against an assumed 2.0 dB outroute downlink fade.

When received by a very small aperture earth station of the small network (G/T = 16.5 dB/K), the resultant carrier-to-background noise ratio is 9.9 dB for the small network out-route downlink. When combined with the out-route uplink, a composite out-route carrier-to-background ratio of 7.7 dB results. This value is 3.4 dB above the minimum value of 4.3 dB needed for satisfactory out-route performance, and indicates that the small network out-route is very robust for VSAT operations.

F. Interference Analysis.

In Assignment of Orbital Locations to Space Stations in the Domestic Fixed-Satellite Service, 54 R.R.2d 550 (1983) ("1983 Orbital Assignments"), the Commission authorized eight domestic satellite systems in the 4/6-GHz and 12/14-GHz bands and assigned 12 orbital positions for the space stations, of those systems. In its Assignment of Orbital Locations to Space Stations in the Domestic Fixed-Satellite Service, FCC 85-396, released August 27, 1985 ("1985 Orbital Assignments"), the Commission authorized the construction of 23 additional space stations plus the assignment of 22 orbital locations. The compatibility of the various domestic systems within the context of the 2° Order has therefore become a major system-design consideration.

The 12/14-GHz band interference analysis has been performed in accordance with the assignments made in 1983 and 1985 at a spacing of 2° between satellites.

The 4/6-GHz band analysis was also performed using a spacing of 2° from each of the currently authorized C-Band space stations. The analysis presented here is based upon the assumptions, techniques, computer program and system characteristics contained in the FCC report, "Reduced Domestic Satellite Orbital Spacing at 4/6 GHz" (OST Report, FCC/OST R83-2, May 1983). In its analysis, NEX has used parameter values employed by the Commission, even in those cases in which other values might be used in practice.

1. Ku-Band Interference Analysis.

In NEX's previously discussed 1983 applications, detailed interference calculations were presented for the there-proposed Ku-Band operation. These analyses concluded that "the interference caused by the NEX SpotNet system will generally allow carrier-to-interference ratios for adjacent satellite systems of greater than 20 dB." See Application, File No. 1824-27-DSS-P/L-83, at 65.

While the Ku-Band payload and transmission parameters described in the current application are different in several respects from the previous application, the cited conclusion regarding the compatibility of the SpotNet Ku-band system with other typical Ku-Band satellites remains valid, as the interference analysis presented in Appendix A demonstrates.

The results of the analysis given in Appendix A are summarized in Tables 16 and 17, infra. The first of these tables shows the interference that the three basic NEX carriers could cause to the carriers of other authorized or previously proposed Ku-Band systems. The carrier-to-interference ratios shown in Table 16 have been calculated for a nominal orbital separation of 2° using the methodology and assumptions described in OST Report FCC/OST R83-2, May 1983. A total of thirty-three different carriers have been examined which are believed to be broadly representative of the full range of carrier types likely to be employed in the 1990s; the transmission parameters for these carriers were extracted from various applications and amendments thereto.

As Table 16 demonstrates, the interference levels likely to be experienced by adjacent satellite carriers are, with minor exceptions, well within established guidelines. Moreover, NEX will not be transmitting high density (e.g., TV/FM and FDM/FM) Ku-Band carriers that are the primary source of unacceptably high adjacent satellite interference.

The interference that NEX carriers would experience due to the presence of adjacent satellite carriers is shown in Table 17. As indicated, interference from adjacent satellite carriers is not generally expected to be of concern, although it will be necessary for NEX to avoid co-frequency operation with adjacent satellite TV/FM carriers.

TABLE 16

POTENTIAL INTERFERENCE INTO ADJACENT SATELLITE CARRIERS FROM NEX CARRIERS

ID	CARRIER TYPE	BAND-WIDTH	SYSTEM	Up - Link E.S. PWR	Up - Link E.S. GAIN	Down-Link SAT. EIRP	Down-Link E.S. GAIN	(C/I)tot Link-A	(C/I)tot Link-B	(C/I)tot Link-C
		(MHz)		(dBW)	(dB)	(dBW)	(dB)	(dB)	(dB)	(dB)
1	TV/FM	36.0	GTE	23.2	56.3	47.0	54.7	29.6	33.9	29.8
2	TV/FM	36.0	GTE	20.5	59.0	47.0	57.4	31.9	35.9	32.3
3	TV/FM	36.0	GTE	23.2	56.3	42.0	54.7	24.9	29.7	25.0
4	TV/FM	36.0	GTE	20.5	59.0	42.0	57.4	27.5	32.1	27.6
5	TV/FM	22.0	GTE	24.3	55.2	47.0	41.3	18.8	23.8	18.8
6	TV/FM	26.0	RCA	26.9	58.2	41.0	49.0	19.8	24.8	19.8
7	TV/FM	26.0	RCA	24.6	55.5	36.5	54.7	20.9	25.9	21.0
8	TV/FM	16.0	SBS	23.7	55.3	47.0	42.4	21.3	26.2	21.3
9	DIGITAL/ 90.0 MBPS	54.0	ASC	24.0	58.0	50.0	57.0	32.7	36.7	33.1
10	DIGITAL/ 60.0 MBPS	36.0	ASC	24.0	58.0	42.0	57.0	27.2	32.0	27.3
11	DIGITAL/ 6.0 MBPS	15.0	ASC	13.7	57.5	33.0	56.0	21.0	25.7	21.1
12	DIGITAL/ 12.0 MBPS	12.0	ASC	12.0	58.0	33.0	57.0	23.6	28.2	23.8
13	DIGITAL/ 1.554 MBPS	3.90	ASC	7.7	57.5	27.0	56.0	20.8	25.6	20.9
14	DIGITAL/ 0.056 MBPS	0.14	ASC	-1.8	55.0	15.0	53.5	20.3	25.1	20.3
15	DIGITAL/ 90.0 MBPS	54.0	GTE	24.3	55.2	47.0	53.7	26.9	31.4	27.1
16	DIGITAL/ 90.0 MBPS	54.0	GTE	24.3	55.2	43.0	53.7	23.1	27.9	23.2
17	DIGITAL/ 60.0 MBPS	36.0	GTE	20.5	59.0	42.0	57.4	27.5	32.1	27.6
18	DIGITAL/ 60.0 MBPS	36.0	GTE	23.2	56.3	42.0	54.7	24.9	29.7	25.0
19	DIGITAL/ 80.0 MBPS	54.0	RCA	24.7	60.6	41.0	59.3	26.8	31.7	26.9
20	DIGITAL/ 8.8 MBPS	16.6	RCA	26.9	58.2	41.0	49.0	21.7	26.7	21.7
21	DIGITAL/ 1.544 MBPS	1.03	RCA	0.5	60.6	22.0	59.3	24.2	29.4	24.9
22	DIGITAL/ 50.0 MBPS	43.0	SBS	24.5	58.2	43.7	57.4	28.5	33.2	28.6
23	DIGITAL/ 50.0 MBPS	43.0	SBS	24.5	55.3	43.7	54.7	25.8	30.5	25.9
24	DIGITAL/ 50.0 MBPS	43.0	SBS	24.5	55.3	46.7	54.7	28.6	33.0	28.8
25	DIGITAL/ 0.512 MBPS	1.229	SCHL	9.0	42.3	16.0	57.1	15.2	20.1	15.9
26	DIGITAL/ 0.512 MBPS	1.229	SCHL	4.8	58.5	27.7	41.1	11.3	16.8	11.8
27	SCPC/PSK 0.056 MBPS	0.039	GTE	-4.8	56.3	9.5	54.7	21.6	26.5	21.6
28	SCPC/PSK 0.056 MBPS	0.039	GTE	-7.5	59.0	9.5	57.4	24.2	29.1	24.3
29	SCPC/PSK 0.056 MBPS	0.064	RCA	0.6	54.5	16.0	53.4	24.6	29.5	24.6
30	SCPC/PSK 0.056 MBPS	0.064	RCA	-5.4	54.5	10.0	53.4	18.6	23.5	18.6
31	SCPC/FM - Audo	0.180	WU	-4.5	55.1	23.0	49.3	22.6	27.1	22.8
32	SCPC/FM - Voice	0.018	FAS	-12.5	48.9	15.9	48.1	23.3	26.7	23.9
33	SCPC/FM - Voice	0.037	RCA	-16.3	59.5	12.0	58.0	26.4	30.0	26.9

NOTE: Link A - Aggregate interference from NEX "medium" network carriers.

Link B - Aggregate interference from NEX "small" network carriers in the inbound direction, i.e., from the remote terminals to the Hub.

Link C - Aggregage interference from NEX "small" network carriers in the outbound direction, i.e., from the Hub to the remote terminals.

TABLE 17

POTENTIAL INTERFERENCE INTO NEX CARRIERS
FROM ADJACENT SATELLITE CARRIERS

ID	CARRIER TYPE	BAND-WIDTH	SYSTEM	Up - Link E.S. PWR	Up - Link E.S. GAIN	Down-Link SAT. EIRP	Down-Link E.S. GAIN	(C/I)tot Link-A	(C/I)tot Link-B	(C/I)tot Link-C
--	----------	-----	------	----	----	----	----	------	------	------
		(MHz)		(dBW)	(dB)	(dBW)	(dB)	(dB)	(dB)	(dB)
1	TV/FM	36.0	GTE	23.2	56.3	47.0	54.7	18.6	14.5	18.4
2	TV/FM	36.0	GTE	20.5	59.0	47.0	57.4	20.6	16.9	19.8
3	TV/FM	36.0	GTE	23.2	56.3	42.0	54.7	19.2	14.8	19.8
4	TV/FM	36.0	GTE	20.5	59.0	42.0	57.4	21.7	17.4	21.9
5	TV/FM	22.0	GTE	24.3	55.2	47.0	41.3	17.7	13.5	17.7
6	TV/FM	26.0	RCA	26.9	58.2	41.0	49.0	15.7	11.2	16.6
7	TV/FM	26.0	RCA	24.6	55.5	36.5	54.7	18.1	13.5	19.0
8	TV/FM	16.0	SBS	23.7	55.3	47.0	42.4	12.2	8.0	12.1
9	DIGITAL/ 90.0 MBPS	54.0	ASC	24.0	58.0	50.0	57.0	20.6	16.8	19.9
10	DIGITAL/ 60.0 MBPS	36.0	ASC	24.0	58.0	42.0	57.0	20.0	15.6	20.7
11	DIGITAL/ 6.0 MBPS	15.0	ASC	13.7	57.5	33.0	56.0	26.4	22.0	27.0
12	DIGITAL/ 12.0 MBPS	12.0	ASC	12.0	58.0	33.0	57.0	26.2	21.9	26.5
13	DIGITAL/ 1.554 MBPS	3.90	ASC	7.7	57.5	27.0	56.0	26.6	22.2	27.1
14	DIGITAL/ 0.056 MBPS	0.14	ASC	-1.8	55.0	15.0	53.5	22.4	17.9	23.2
15	DIGITAL/ 90.0 MBPS	54.0	GTE	24.3	55.2	47.0	53.7	21.0	16.8	21.0
16	DIGITAL/ 90.0 MBPS	54.0	GTE	24.3	55.2	43.0	53.7	21.4	17.0	22.0
17	DIGITAL/ 60.0 MBPS	36.0	GTE	20.5	59.0	42.0	57.4	23.2	18.9	23.5
18	DIGITAL/ 60.0 MBPS	36.0	GTE	23.2	56.3	42.0	54.7	20.8	16.3	21.4
19	DIGITAL/ 80.0 MBPS	54.0	RCA	24.7	60.6	41.0	59.3	21.2	16.7	22.0
20	DIGITAL/ 8.8 MBPS	16.6	RCA	26.9	58.2	41.0	49.0	13.9	9.4	14.8
21	DIGITAL/ 1.544 MBPS	1.03	RCA	0.5	60.6	22.0	59.3	28.4	23.5	28.0
22	DIGITAL/ 50.0 MBPS	43.0	SBS	24.5	58.2	43.7	57.4	20.2	15.8	20.8
23	DIGITAL/ 50.0 MBPS	43.0	SBS	24.5	55.3	43.7	54.7	20.2	15.8	20.8
24	DIGITAL/ 50.0 MBPS	43.0	SBS	24.5	55.3	46.7	54.7	19.9	15.7	20.0
25	DIGITAL/ 0.512 MBPS	1.229	SCHL	9.0	42.3	16.0	57.1	20.6	16.0	21.7
26	DIGITAL/ 0.512 MBPS	1.229	SCHL	4.8	58.5	27.7	41.1	24.1	19.9	24.1
27	SCPC/PSK 0.056 MBPS	0.039	GTE	-4.8	56.3	9.5	54.7	19.9	15.4	20.8
28	SCPC/PSK 0.056 MBPS	0.039	GTE	-7.5	59.0	9.5	57.4	22.5	18.0	23.3
29	SCPC/PSK 0.056 MBPS	0.064	RCA	0.6	54.5	16.0	53.4	16.7	12.1	17.5
30	SCPC/PSK 0.056 MBPS	0.064	RCA	-5.4	54.5	10.0	53.4	22.7	18.1	23.5
31	SCPC/FM - Audo	0.180	WU	-4.5	55.1	23.0	49.3	24.5	20.8	23.4
32	SCPC/FM - Voice	0.018	FAS	-12.5	48.9	15.9	48.1	22.1	18.6	20.9
33	SCPC/FM - Voice	0.037	RCA	-16.3	59.5	12.0	58.0	29.1	25.6	27.8

NOTE: Link A - Interference into NEX "medium" network carriers.
Link B - Interference into NEX "small" network carriers in the inbound direction, i.e., from the remote terminals to the Hub.
Link C - Interference into NEX "small" network carriers in the outbound direction, i.e., from the Hub to the remote terminals.

2. C-Band.

The interference model used to analyze the potential for C-Band interference between satellites is the "Adjacent Satellite Interference Program" described in OST Report FCC/OST R83-2. This report describes in detail the interference computation formulas used and the theoretical basis behind the computer model. In addition to the standard, conservative assumptions implicit in the model, the following additional assumptions were made:

1. The interference spectrum used for TV/FM signals is a 1.2-MHz energy dispersal spectrum.

2. SCPC and small FDMA carriers have transponder frequency plans which avoid frequencies within ± 1.5 MHz of the transponder center frequency.

3. Earth station antenna radiation patterns follow a 29-25 log X curve where X is the geocentric angle between satellites, in degrees.

4. A maximum off-axis cross-polarization isolation in the earth station of 10 dB.

The model calculates its results by assuming that each of the satellite carrier types is carried by a satellite located 2° away from each other carrier type. Given this assumption, the carrier-to-interference ration (C/I) is calculated for the carrier and used to determine the interference level in the receiver. The interference level is then compared to the appropriate interference criterion for the "victim" receiver to determine whether the interfering signal meets the criterion. If the criterion is not met, the ratio of the interfering signal to the

interference criterion is calculated in dB. This process is carried out for each potential interferer/victim pair.

The results of the analysis of the C-band interference are contained in Appendix A. These results confirm that the NEX spectrum is compatible with other C-Band uses at 2° spacing. Interference from and to NEX is within the limits set forth in the Commission's Report on 2° spacing in almost all cases, and in those few instances where the limits are exceeded, coordination between users can resolve the problem.

G. Preferred Locations of the SpotNet Satellites and Reasons Therefor.

The SpotNet satellite system will require the assignment of only two orbital locations. The advantage of combined system operation in the 4/6-GHz and 12/14-GHz frequency range from the same orbital locations were discussed supra.

Three major considerations shaped NEX's decision to request the 101° W.L. and 93° W.L. orbital locations. The first consideration is that of 50-state coverage. As Figure 1 illustrates, while neither slot can facilitate full 50-state coverage, NEX intends to provide both C-Band and Ku-Band coverage to the southern portion of Alaska and to Hawaii.[1] The second

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[1] As the Commission stated in 1985 Orbital Assignments, supra, FCC 85-396, Ku-Band operations require a minimum elevation angle of 10°. See id. at 6 n.16. Figure 1B, supra, illustrates that although portions of southern Alaska can be covered from 101° W.L. in Ku-Band, coverage of the entire state from that orbital position cannot be achieved. Thus, while it is clear that 93°

(continued...)

consideration is the adverse effect of heavy rain on 12/14-GHz operations, particularly in the eastern and southeastern regions of the country; orbital locations toward the center of the domestic geostationary arc are desirable to permit high elevation angles that minimize rainfall attenuation and depolarization effects. A final consideration is that since SpotNet will have less flexibility in beam shaping than satellites with CONUS or large regional coverage beams, since controlled beam coverage is essential in achieving intensive frequency reuse while matching beams to areas of traffic density. Locations near the center of the arc are necessary in order to allow coverage of the beams to be controlled more effectively.

In developing its orbital assignment policy, the Commission stated that "[n]ew entrants relying on speculative satellite traffic are initially assigned the minimum number of orbital locations needed to establish market presence." Assignment of Orbital Locations to Space Stations in the Domestic Fixed-Satellite Service, 84 F.C.C.2d 584, 588 (1981) ("1981 Orbital Assignments"). Generally, this has meant the assignment of two slots to new entrants. Id. at 603; see also 1985 Orbital Assignments at ¶ 17. Further, the Commission has adopted a

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[1](...continued)
W.L. is not a 50-state location, see Figure 1A, supra, it may be open to reasonable debate as to whether 101° W.L. so qualifies for Ku-Band. The point here is that even if 101° W.L. is held to be a 50-state location, it is the only one NEX has requested, in compliance with Commission policy.

companion policy in which satellite operators are afforded "an opportunity to develop innovative services to all 50 states in an efficient manner over the same satellite." 1981 Orbital Assignments at 605; see also 1985 Orbital Assignments at ¶¶ 7, 17. Generally, this has resulted in new satellite operators being assigned at least one 50-state coverage position. Id.

Under these policies, NEX should be entitled to receive at least one 50-state coverage orbital position. NEX's proposal, however, is not dependent upon having full 50-state coverage, thus enabling it to request the 101° W.L. and 93° W.L. locations.

H. Dates by Which Significant Milestones Are Likely to be Achieved.

A detailed schedule specifying concrete dates by which significant milestones in establishment of the SpotNet satellite system are planned to be achieved is included at Table 18.

TABLE 18

Schedule of Implementation

Negotiations Completed and Contracts Executed

a.	Spacecraft RFP Issued	--	January 1989
b.	Spacecraft Contractor Selected	--	May 1989
c.	Spacecraft Contract Executed	--	July 1989
d.	Launch Services Contract Executed	--	November 1989
e.	Financing Complete	--	November 1989

Spacecraft Implementation

Satellite Due Date

Event	SpotNet 1	SpotNet 2	Spare
Spacecraft Construction Begun	August 1989	July 1990	January 1991
Spacecraft Construction Complete	January 1993	July 1993	January 1994
Spacecraft Launched	March 1993	September 1993	
Spacecraft in Service	June 1993	December 1993	

I. & J. Detailed Schedule of Estimated Investment Costs, Operating Costs, and Revenue Requirements for Proposed System by Year.

NEX has analyzed the costs associated with the satellites, TT&C, Network Control Center, marketing, and management of the initially configured satellite communication system that is the subject of this application, as set out in Table 19. Each major component of the total system has been divided into logical subcomponents, with assigned costs based on established prices and published data. Based on this detailed analysis, the financial projections of the company have been determined.

TABLE 19

MEX COSTS & REVENUE REQUIREMENTS
($M)
FISCAL YEAR

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
WORKING CAPITAL															
Development	1.2	2.5	3.7	2.5	1.0										
Marketing	1.1	2.4	4.5	6.8	8.2	17.2	24.0	31.6	34.0	36.6	39.4	42.4	45.7	32.1	10.4
Operations	0.5	1.1	1.4	1.8	4.4	24.2	48.6	62.4	87.1	101.9	113.2	118.2	121.3	116.8	110.1
Administration	0.8	1.0	1.3	1.5	1.7	2.0	2.2	2.3	2.5	2.6	2.7	2.9	3.0	3.2	2.3
Total	3.6	7.0	10.9	12.6	15.3	43.4	74.8	96.3	123.6	141.1	155.3	163.5	170.0	152.1	122.8
CAPITAL EXPENDITURES															
Satellite Construction															
Spotnet 1		5.0	15.0	30.0	30.0	20.0									
Spotnet 2			20.0	30.0	30.0	20.0									
Spare				20.0	20.0	20.0	20.0								
Satellite Launch Service															
2 Satellites		1.0	12.0	20.0	27.0	20.0									
Launch Insurance															
2 Satellites		1.0	8.0	18.0	18.0	10.0									
TT&HC		3.9	5.2	4.7	3.5	0.7									
Total	0	10.9	60.2	122.7	128.5	90.7	20.0								
Depreciation						20.3	90.8	71.3	57.7	53.8	53.8	53.8	42.3		
Revenue Requirement						25.4	128.6	212.6	280.6	327.4	380.2	390.1	420.1	405.9	380.1

As shown in Table 19, the estimated construction, launch, and other pre-operational costs for the two in-orbit and one ground spare satellite system total $504.1 million. First year annual operating expenses (inclusive of inflation), beginning in the 1993-94 time frame, when the two-satellite system is proposed to become operational, are projected to be $59.1 million. In order to fund the construction, launch, and first-year operation of the SpotNet system, NEX has obtained the firm commitment of BNI, its corporate parent, that the necessary funds, in an amount in excess of $563.2 million, will be made available for this purpose. Attached hereto as Exhibit A is a letter from Mr. Gerald Grinstein, BNI's Vice Chairman, certifying to the foregoing. Also contained in Exhibit A are copies of the most recent Form 10Ks filed by BNI and its primary wholly-owned subsidiary, Burlington Northern Railroad Company, which provide the supporting documentation required by 47 C.F.R. § 25.391(d).

K. Legal Qualifications of Applicant.

A Common Carrier and Satellite Radio Licensee Qualification Report (FCC Form 430) is being filed simultaneously herewith. A copy is attached hereto as Exhibit B.

L. Statement of Whether Space Station is to be Operated on Common Carrier or Non-Common Carrier Basis.

The SpotNet system is intended primarily as a non-common carrier system, in that NEX itself will deal with its customers on

a non-carrier basis. NEX recognizes, however, that it is not yet in a position to supply the detailed information required by the Commission in Transponder Sales Order, 90 F.C.C.2d 1238, 1260 (1982), to enable the agency to apply the NARUC I test to NEX's marketing plans and to make a public-interest determination as to its non-common carrier proposal. Therefore, NEX is prepared to pursue its applications and to offer its services on a common carrier basis until such time as it receives authorization from the Commission to operate on a non-common carrier basis. Full and detailed information as required by Section 63.01 of the Rules, 47 C.F.R. § 63.01, concerning its proposal to provide service as a common carrier is provided in this application.

M. Public Interest Considerations.

The essence of the Commission's successful open-entry policy for the domestic satellite industry is the desire "to allow room and incentive for the development of innovative services and technologies." 1981 Orbital Assignment, 84 F.C.C.2d at 601. The FCC has known for some time that the use of multiple narrow spot beams results in a highly efficient, high-capacity satellite design; indeed, even while denying NEX's 1983 application, the Commission acknowledged the potential superiority of NEX's spot beam technology over the proposals of others. See National Exchange, Inc., supra, 1 FCC Rcd at 689 n.35. Nonetheless, the Commission's declared policy is not to dictate particular designs, leaving such choices to the individual applicants, who are in the

best position to make the "complex trade-offs between technical, economic, operational and marketing factors." 1981 Orbital Assignments, 84 F.C.C.2d at 594; 2° Order, 54 R.R.2d at 612.

The Commission has also made clear, however, that in the face of the growing congestion of the orbital arc, it places a premium on efficient use of available orbital locations, and that it would look carefully at system design in terms of satellite capacity at each orbital location. See 1981 Orbital Assignments at 595-96; 2° Order at 598. Clearly, grant of NEX's SpotNet application, the technological basis of which the Commission has already acknowledged is directly responsive to this policy, see National Exchange, Inc., supra, 1 FCC Rcd at 689 n.35, would serve the public interest.

The SpotNet system represents a significant advance in the conception of satellite communication system design and use, promising great benefits to customers of satellite services and the public at large. The design has the practical effect of expanding the capacity of the 12/14-GHz-frequency band. This capability -- together with the communication payload power to sustain operation in this large bandwidth and SpotNet's unique capability to interconnect traffic among all the antenna patterns of a satellite -- expands the utility of SpotNet many times as compared to a conventional satellite system.

The spectrum and orbital efficiency that characterize the SpotNet system also contribute to the substantial public benefit

of offering its customers full interconnectivity using small, low-cost, highly reliable and easily installed customer-premise earth stations. In terms of both cost to the user and operational flexibility, NEX's SpotNet represents a significant advance over any other existing or proposed satellite system.

In brief, the NEX application entirely fulfills the goals of the FCC's open-entry domestic satellite policy. It has proposed an "innovative application of satellite technology to satisfy the telecommunications needs of this country." 2° Order, 54 R.R.2d at 602. Its application should be granted.

APPENDIX A

1. Ku-Band Interference Analysis.

The methodology and assumptions used in the Ku-Band interference assessment are essentially those used by the Commission in the past (Ref: FCC/OST R83-2). The major assumptions are discussed below:

(1) all earth station antennas conform to the standard 29 -25 Log(theta) sidelobe envelope.

(2) a nominal angular separation of 2° is used in all calculations, (i.e., the topocentric separation is approximated by the geocentric separation and station keeping errors are ignored).

(3) the path loss differentials on both the uplink and the downlink are negligible.

(4) both the wanted and interfering earth stations lie on their respective -3dB contours.

(5) the wanted and interfering signals are co-polarized.

Given these assumptions, the following uplink and downlink C/I ratios result:

$$(C/I)_u = Pt + G_1 - p_t - g_1 \text{ (theta)} + Q$$

$$(C/I)_d = E + G_4 - e - G_4 \text{ (theta)} + Q$$

where:

$(C/I)_u$	=	uplink wanted-to-interfering carrier ratio
$(C/I)_d$	=	downlink wanted-to-interfering carrier ratio
P_t	=	transmit power of the wanted carrier at the input to the wanted earth station antenna
p_t	=	transmit power of the interfering carrier at the input to the interfering earth station antenna
G_1	=	transmit antenna gain of the wanted earth station
g_1 (theta)	=	antenna gain of the interfering earth station in the direction of the wanted satellite
E	=	E.I.R.P. of the wanted carrier
e	=	E.I.R.P. of the interfering carrier
G_4	=	receive gain of the wanted earth station in the direction of the wanted satellite
G_4 (theta)	=	receive gain of the wanted earth station in the direction of the interfering satellite
Q	=	ratio of total carrier power to the effective total interfering power within the wanted carrier receiver pass band. For multiple interfering carriers, Q is simply 10 Log(N_i) where N_i is the number of interfering carriers. For single carriers, Q is a function of the carrier power spectral density.

The total link carrier-to-interference ratio, $(C/I)_{tot}$, is the power ratio sum of $(C/I)_u$ and $(C/I)_d$.

It should also be noted that when calculating the interference caused to narrow band carriers by a TV/FM carrier, the latter is assumed to have a normalized interference spectral power density of -74 dB/Hz; i.e., it is implicitly assumed that

narrowband carriers will not be placed on the same frequency as adjacent satellite TV carriers.

In order to assess the likelihood of harmful interference into adjacent satellite systems, a total of thirty-three carriers have been examined, which are believed to be broadly representative of the full range of Ku-Band carriers likely to be employed in the 1990s. The transmission parameters for these carriers were obtained from various satellite applications and FCC documents. Although some of the carriers in this set are from systems that are no longer planned, they represent services likely to be provided on other satellites at some future date and have, for that reason, been included in this analysis.

Table A-1 shows the potential interference into adjacent satellite carriers from NEX "medium network" 1.544 mbps digital carriers. With only a few minor exceptions, the aggregate $(C/I)_{tot}$ meets or exceeds generally accepted (C/I) interference objectives.

Table A-2 shows the potential interference into the NEX "medium network" carrier from adjacent satellite carriers. As this table demonstrates, the NEX medium network carrier is relatively insensitive to interference from adjacent satellite carriers.

Table A-3 shows the potential interference into adjacent satellite carriers from NEX "small network" in-route carriers, i.e., from the 96 kbps TDMA carrier transmitted from small 1.2

meter remote terminals to a 3 meter hub station. In all cases, the aggregate $(C/I)_{tot}$ exceeds generally accepted (C/I) interference objectives.

Table A-4 shows the potential interference into NEX "small network" in-route carriers from adjacent satellite carriers. As indicated, this carrier is somewhat sensitive to uplink interference and some degree of coordination will be necessary with adjacent satellite TV carriers. However, by virtue of the fact that acceptable performance is achieved at an operating (C/N+I) as low as 4.3 dB, interference from other carrier types is not expected to be significant.

Table A-5 shows the potential interference into adjacent satellite carriers from the NEX "small network" out-route carrier, i.e., from the 96 kbps TDM carrier transmitted from a 3 meter hub station to small 1.2 meter remote terminals. With only a few minor exceptions, the aggregate $(C/I)_{tot}$ meets or exceeds generally accepted (C/I) interference objectives.

Table A-6 shows the potential interference into the NEX "small network" out-route carrier from adjacent satellite carriers. As this table demonstrates, the NEX "small network" out-route carrier is relatively insensitive to interference from adjacent satellite carriers.

As the analysis described above demonstrates, NEX Ku-Band carriers will not cause excess interference into adjacent satellite systems, even at an orbital separation of 2°. Indeed, by virtue of the fact that the NEX Ku-Band payload is not intended for the transmission of TV/FM carriers, it will produce far less interference than other existing and authorized Ku-Band satellites.

TABLE A-1

INTERFERENCE INTO ADJACENT SATELLITE
CARRIERS FROM THE NEX "MEDIUM NETWORK" CARRIER

CARRIER ID NUMBER	:	1	2	3	4	5
CARRIER TYPE	:	TV/FM	TV/FM	TV/FM	TV/FM	TV/FM
BANDWIDTH	(MHz):	36	36	36	36	22
DATA RATE	(MBPs):	N/A	N/A	N/A	N/A	N/A
NO. CHANNELS PER CARRIER	:	1	1	1	1	1
(C/I)up	(DB):	53.6	53.6	53.6	53.6	53.6
(C/I)dn	(DB):	44.2	46.9	39.2	41.9	30.8
(C/I)tot [1 carrier]	(DB):	43.8	46.1	39.1	41.6	30.8
(C/I)tot [multiple]	(DB):	29.6	31.9	24.9	27.5	18.8
BASEBAND S/I	(DB):	69.8	72.1	63	65.5	50.7
BASEBAND NOISE	(pWOp):	N/A	N/A	N/A	N/A	N/A

CARRIER ID NUMBER	:	6	7	8	9	10
CARRIER TYPE	:	TV/FM	TV/FM	TV/FM	DIGITAL	DIGITAL
BANDWIDTH	(MHz):	26	26	16	54	36
DATA RATE	(MBPs):	N/A	N/A	N/A	90	60
NO. CHANNELS PER CARRIER	:	1	1	1	1	1
(C/I)up	(DB):	59.2	54.2	53.1	56.1	56.1
(C/I)dn	(DB):	32.5	33.7	31.9	49.5	41.5
(C/I)tot [1 carrier]	(DB):	32.5	33.7	31.9	48.7	41.4
(C/I)tot [multiple]	(DB):	19.8	20.9	21.3	32.7	27.2
BASEBAND S/I	(DB):	54.8	56	50.7	N/A	N/A
BASEBAND NOISE	(pWOp):	N/A	N/A	N/A	N/A	N/A

CARRIER ID NUMBER	:	11	12	13	14	15
CARRIER TYPE	:	DIGITAL	DIGITAL	DIGITAL	DIGITAL	DIGITAL
BANDWIDTH	(MHz):	15	10	3.9	.14	54
DATA RATE	(MBPs):	6	12	1.544	.056	90
NO. CHANNELS PER CARRIER	:	1	1	1	1	1
(C/I)up	(DB):	45.3	44.1	39.3	36.7	53.6
(C/I)dn	(DB):	31.5	32.5	25.5	20.4	43.2
(C/I)tot [1 carrier]	(DB):	31.3	32.2	25.3	20.3	42.8
(C/I)tot [multiple]	(DB):	21.0	23.6	20.8	20.3	26.9
BASEBAND S/I	(DB):	N/A	N/A	N/A	N/A	N/A
BASEBAND NOISE	(pWOp):	N/A	N/A	N/A	N/A	N/A

CARRIER ID NUMBER	:	16	17	18	19	20
CARRIER TYPE	:	DIGITAL	DIGITAL	DIGITAL	DIGITAL	DIGITAL
BANDWIDTH	(MHz):	54	36	36	54	16.6
DATA RATE	(MBPs):	90	60	60	80	8.8
NO. CHANNELS PER CARRIER	:	1	1	1	1	1
(C/I)up	(DB):	53.6	53.6	53.6	59.4	59.2
(C/I)dn	(DB):	39.2	41.9	39.2	42.8	32.5
(C/I)tot [1 carrier]	(DB):	39.1	41.6	39.1	42.7	32.5
(C/I)tot [multiple]	(DB):	23.1	27.5	24.9	26.8	21.7
BASEBAND S/I	(DB):	N/A	N/A	N/A	N/A	N/A
BASEBAND NOISE	(pWOp):	N/A	N/A	N/A	N/A	N/A

TABLE A-1 (Cont'd)

INTERFERENCE INTO ADJACENT SATELLITE
CARRIERS FROM THE NEX "MEDIUM NETWORK" CARRIER

CARRIER ID NUMBER	:	21	22	23	24	25
CARRIER TYPE	:	DIGITAL	DIGITAL	DIGITAL	DIGITAL	DIGITAL
BANDWIDTH	(MHz):	1.030	43.0	43	43	1.229
DATA RATE	(MBPs):	1.544	50	50	50	.512
NO. CHANNELS PER CARRIER	:	1	1	1	1	1
(C/I)up	(DB):	35.9	56.8	53.9	53.9	25.4
(C/I)dn	(DB):	24.5	43.6	40.9	43.9	15.6
(C/I)tot [1 carrier]	(DB):	24.2	43.4	40.7	43.5	15.2
(C/I)tot [multiple]	(DB):	24.2	28.5	25.8	28.6	15.2
BASEBAND S/I	(DB):	N/A	N/A	N/A	N/A	N/A
BASEBAND NOISE	(pWOp):	N/A	N/A	N/A	N/A	N/A

CARRIER ID NUMBER	:	26	27	28	29	30
CARRIER TYPE	:	DIGITAL	SCPC/PSK	SCPC/PSK	SCPC/PSK	SCPC/PSK
BANDWIDTH	(MHz):	1.229	.039	.039	.064	.064
DATA RATE	(MBPs):	.512	.056	.056	.056	.056
NO. CHANNELS PER CARRIER	:	1	1	1	1	1
(C/I)up	(DB):	37.4	40.5	40.5	42.0	36.0
(C/I)dn	(DB):	11.3	21.6	24.3	24.7	18.7
(C/I)tot [1 carrier]	(DB):	11.3	21.6	24.2	24.6	18.6
(C/I)tot [multiple]	(DB):	11.3	21.6	24.2	24.6	18.6
BASEBAND S/I	(DB):	N/A	N/A	N/A	N/A	N/A
BASEBAND NOISE	(pWOp):	N/A	N/A	N/A	N/A	N/A

CARRIER ID NUMBER	:	31	32	33
CARRIER TYPE	:	SCPC/FM	SCPC/FM	SCPC/FM
BANDWIDTH	(MHz):	.180	.018	.037
DATA RATE	(MBPs):	N/A	N/A	N/A
NO. CHANNELS PER CARRIER	:	1	1	1
(C/I)up	(DB):	33.0	28.8	32.4
(C/I)dn	(DB):	23.1	24.8	27.6
(C/I)tot [1 carrier]	(DB):	22.6	23.3	26.4
(C/I)tot [multiple]	(DB):	22.6	23.3	26.4
BASEBAND S/I	(DB):	62.1	63.3	77.6
BASEBAND NOISE	(pWOp):	606	457	17

TABLE A-2

INTERFERENCE INTO THE NEX "MEDIUM NETWORK"
CARRIER FROM ADJACENT SATELLITE CARRIERS

CARRIER ID NUMBER	:	1	2	3	4	5
CARRIER TYPE	:	TV/FM	TV/FM	TV/FM	TV/FM	TV/FM
BANDWIDTH	(MHz):	36	36	36	36	22
DATA RATE	(MBPs):	N/A	N/A	N/A	N/A	N/A
NO. CHANNELS PER CARRIER	:	1	1	1	1	1
(C/I)up	(DB):	19.5	22.2	19.5	22.2	18.4
(C/I)dn	(DB):	25.7	25.7	30.7	30.7	25.7
(C/I)tot [1 carrier]	(DB):	18.6	20.6	19.2	21.7	17.7
(C/I)tot [multiple]	(DB):	18.6	20.6	19.2	21.7	17.7

CARRIER ID NUMBER	:	6	7	8	9	10
CARRIER TYPE	:	TV/FM	TV/FM	TV/FM	DIGITAL	DIGITAL
BANDWIDTH	(MHz):	26	26	16	54	36
DATA RATE	(MBPs):	N/A	N/A	N/A	90	60
NO. CHANNELS PER CARRIER	:	1	1	1	1	1
(C/I)up	(DB):	15.8	18.1	13.0	22.1	20.3
(C/I)dn	(DB):	31.7	36.2	19.7	26.1	32.3
(C/I)tot [1 carrier]	(DB):	15.7	18.1	12.2	20.6	20.0
(C/I)tot [multiple]	(DB):	15.7	18.1	12.2	20.6	20.0

CARRIER ID NUMBER	:	11	12	13	14	15
CARRIER TYPE	:	DIGITAL	DIGITAL	DIGITAL	DIGITAL	DIGITAL
BANDWIDTH	(MHz):	15	10	3.9	.14	54
DATA RATE	(MBPs):	6	12	1.544	.056	90
NO. CHANNELS PER CARRIER	:	1	1	1	1	1
(C/I)up	(DB):	26.8	26.7	26.9	31.3	21.8
(C/I)dn	(DB):	37.5	35.7	37.6	44.5	29.1
(C/I)tot [1 carrier]	(DB):	26.4	26.2	26.6	31.1	21.0
(C/I)tot [multiple]	(DB):	26.4	26.2	26.6	22.4	21.0

CARRIER ID NUMBER	:	16	17	18	19	20
CARRIER TYPE	:	DIGITAL	DIGITAL	DIGITAL	DIGITAL	DIGITAL
BANDWIDTH	(MHz):	54	36	36	54	16.6
DATA RATE	(MBPs):	90	60	60	80	8.8
NO. CHANNELS PER CARRIER	:	1	1	1	1	1
(C/I)up	(DB):	21.8	23.8	21.1	21.4	14.0
(C/I)dn	(DB):	33.1	32.3	32.3	35.1	29.9
(C/I)tot [1 carrier]	(DB):	21.4	23.2	20.8	21.2	13.9
(C/I)tot [multiple]	(DB):	21.4	23.2	20.8	21.2	13.9

TABLE A-2 (Cont'd)

INTERFERENCE INTO THE NEX "MEDIUM NETWORK"
CARRIER FROM ADJACENT SATELLITE CARRIERS

CARRIER ID NUMBER	:	21	22	23	24	25
CARRIER TYPE	:	DIGITAL	DIGITAL	DIGITAL	DIGITAL	DIGITAL
BANDWIDTH	(MHz):	1.030	43.0	43	43	1.229
DATA RATE	(MBPs):	1.544	50	50	50	.512
NO. CHANNELS PER CARRIER	:	1	1	1	1	1
(C/I)up	(DB):	29.0	20.6	20.6	20.6	20.6
(C/I)dn	(DB):	37.5	31.4	31.4	28.4	43.6
(C/I)tot [1 carrier]	(DB):	28.5	20.2	20.2	19.9	20.6
(C/I)tot [multiple]	(DB):	28.4	20.2	20.2	19.9	20.6

CARRIER ID NUMBER	:	26	27	28	29	30
CARRIER TYPE	:	DIGITAL	SCPC/PSK	SCPC/PSK	SCPC/PSK	SCPC/PSK
BANDWIDTH	(MHz):	1.229	.039	.039	.064	.064
DATA RATE	(MBPs):	.512	.056	.056	.056	.056
NO. CHANNELS PER CARRIER	:	1	1	1	1	1
(C/I)up	(DB):	24.8	34.3	37.0	28.9	34.9
(C/I)dn	(DB):	31.9	50.0	50.0	43.5	49.5
(C/I)tot [1 carrier]	(DB):	24.1	34.2	36.8	28.8	34.8
(C/I)tot [multiple]	(DB):	24.1	19.9	22.5	16.7	22.7

CARRIER ID NUMBER	:	31	32	33
CARRIER TYPE	:	SCPC/FM	SCPC/FM	SCPC/FM
BANDWIDTH	(MHz):	.180	.018	.037
DATA RATE	(MBPs):	N/A	N/A	N/A
NO. CHANNELS PER CARRIER	:	1	1	1
(C/I)up	(DB):	34.0	42.0	45.8
(C/I)dn	(DB):	36.5	43.6	47.5
(C/I)tot [1 carrier]	(DB):	32.1	39.7	43.6
(C/I)tot [multiple]	(DB):	24.5	22.1	29.1

TABLE A-3

INTERFERENCE INTO ADJACENT SATELLITE CARRIERS
FROM NEX "SMALL NETWORK" IN-ROUTE CARRIERS

CARRIER ID NUMBER	:	1	2	3	4	5
CARRIER TYPE	:	TV/FM	TV/FM	TV/FM	TV/FM	TV/FM
BANDWIDTH	(MHz):	36	36	36	36	22
DATA RATE	(MBPs):	N/A	N/A	N/A	N/A	N/A
NO. CHANNELS PER CARRIER	:	1	1	1	1	1
(C/I)up	(DB):	61.5	61.5	61.5	61.5	61.5
(C/I)dn	(DB):	56.2	58.9	51.2	53.9	42.8
(C/I)tot [1 carrier]	(DB):	55.1	57.0	50.8	53.2	42.8
(C/I)tot [multiple]	(DB):	33.9	35.9	29.7	32.1	23.8
BASEBAND S/I	(DB):	74.1	76.1	67.7000	70.1	55.7
BASEBAND NOISE	(pWOp):	N/A	N/A	N/A	N/A	N/A

CARRIER ID NUMBER	:	6	7	8	9	10
CARRIER TYPE	:	TV/FM	TV/FM	TV/FM	DIGITAL	DIGITAL
BANDWIDTH	(MHz):	26	26	16	54	36
DATA RATE	(MBPs):	N/A	N/A	N/A	90	60
NO. CHANNELS PER CARRIER	:	1	1	1	1	1
(C/I)up	(DB):	67.1	62.1	61.0	64.0	64.0
(C/I)dn	(DB):	44.5	45.7	43.9	61.5	53.5
(C/I)tot [1 carrier]	(DB):	44.5	45.6	43.8	59.6	53.2
(C/I)tot [multiple]	(DB):	24.8	25.9	26.2	36.7	32.0
BASEBAND S/I	(DB):	59.8	61	55.7	N/A	N/A
BASEBAND NOISE	(pWOp):	N/A	N/A	N/A	N/A	N/A

CARRIER ID NUMBER	:	11	12	13	14	15
CARRIER TYPE	:	DIGITAL	DIGITAL	DIGITAL	DIGITAL	DIGITAL
BANDWIDTH	(MHz):	15	10	3.9	.14	54
DATA RATE	(MBPs):	6	12	1.544	.056	90
NO. CHANNELS PER CARRIER	:	1	1	1	1	1
(C/I)up	(DB):	53.2	52.0	47.2	37.6	61.5
(C/I)dn	(DB):	43.5	44.5	37.5	25.4	55.2
(C/I)tot [1 carrier]	(DB):	43.1	43.8	37.1	25.1	54.3
(C/I)tot [multiple]	(DB):	25.7	28.2	25.6	25.1	31.4
BASEBAND S/I	(DB):	N/A	N/A	N/A	N/A	N/A
BASEBAND NOISE	(pWOp):	N/A	N/A	N/A	N/A	N/A

CARRIER ID NUMBER	:	16	17	18	19	20
CARRIER TYPE	:	DIGITAL	DIGITAL	DIGITAL	DIGITAL	DIGITAL
BANDWIDTH	(MHz):	54	36	36	54	16.6
DATA RATE	(MBPs):	90	60	60	80	8.8
NO. CHANNELS PER CARRIER	:	1	1	1	1	1
(C/I)up	(DB):	61.5	61.5	61.5	67.3	67.1
(C/I)dn	(DB):	51.2	53.9	51.2	54.8	44.5
(C/I)tot [1 carrier]	(DB):	50.8	53.2	50.8	54.6	44.5
(C/I)tot [multiple]	(DB):	27.9	32.1	29.7	31.7	26.7
BASEBAND S/I	(DB):	N/A	N/A	N/A	N/A	N/A
BASEBAND NOISE	(pWOp):	N/A	N/A	N/A	N/A	N/A

TABLE A-3 (Cont'd)

INTERFERENCE INTO ADJACENT SATELLITE CARRIERS
FROM NEX "SMALL NETWORK" IN-ROUTE CARRIERS

CARRIER ID NUMBER	:	21	22	23	24	25
CARRIER TYPE	:	DIGITAL	DIGITAL	DIGITAL	DIGITAL	DIGITAL
BANDWIDTH	(MHz):	1.030	43.0	43	43	1.229
DATA RATE	(MBPs):	1.544	50	50	50	.512
NO. CHANNELS PER CARRIER	:	1	1	1	1	1
(C/I)up	(DB):	43.1	64.7	61.8	61.8	33.3
(C/I)dn	(DB):	35.8	55.6	52.9	55.9	27.6
(C/I)tot [1 carrier]	(DB):	35.1	55.1	52.4	54.9	26.6
(C/I)tot [multiple]	(DB):	29.4	33.2	30.5	33.0	20.1
BASEBAND S/I	(DB):	N/A	N/A	N/A	N/A	N/A
BASEBAND NOISE	(pWOp):	N/A	N/A	N/A	N/A	N/A

CARRIER ID NUMBER	:	26	27	28	29	30
CARRIER TYPE	:	DIGITAL	SCPC/PSK	SCPC/PSK	SCPC/PSK	SCPC/PSK
BANDWIDTH	(MHz):	1.229	.039	.039	.064	.064
DATA RATE	(MBPs):	.512	.056	.056	.056	.056
NO. CHANNELS PER CARRIER	:	1	1	1	1	1
(C/I)up	(DB):	45.3	41.4	41.4	42.9	36.9
(C/I)dn	(DB):	23.3	26.6	29.3	29.7	23.7
(C/I)tot [1 carrier]	(DB):	23.3	26.5	29.1	29.5	23.5
(C/I)tot [multiple]	(DB):	16.8	26.5	29.1	29.5	23.5
BASEBAND S/I	(DB):	N/A	N/A	N/A	N/A	N/A
BASEBAND NOISE	(pWOp):	N/A	N/A	N/A	N/A	N/A

CARRIER ID NUMBER	:	31	32	33
CARRIER TYPE	:	SCPC/FM	SCPC/FM	SCPC/FM
BANDWIDTH	(MHz):	.180	.018	.037
DATA RATE	(MBPs):	N/A	N/A	N/A
NO. CHANNELS PER CARRIER	:	1	1	1
(C/I)up	(DB):	33.9	29.7	33.3
(C/I)dn	(DB):	28.1	29.8	32.6
(C/I)tot [1 carrier]	(DB):	27.1	26.7	30.0
(C/I)tot [multiple]	(DB):	27.1	26.7	30.0
BASEBAND S/I	(DB):	66.5	66.8	81.1
BASEBAND NOISE	(pWOp):	219	208	7

TABLE A-4

INTERFERENCE INTO NEX "SMALL NETWORK" IN-ROUTE CARRIERS FROM ADJACENT SATELLITE CARRIERS

CARRIER ID NUMBER	:	1	2	3	4	5
CARRIER TYPE	:	TV/FM	TV/FM	TV/FM	TV/FM	TV/FM
BANDWIDTH	(MHz):	36	36	36	36	22
DATA RATE	(MBPs):	N/A	N/A	N/A	N/A	N/A
NO. CHANNELS PER CARRIER	:	1	1	1	1	1
(C/I)up	(DB):	14.9	17.6	14.9	17.6	13.8
(C/I)dn	(DB):	24.7	24.7	29.7	29.7	24.7
(C/I)tot [1 carrier]	(DB):	14.5	16.9	14.8	17.4	13.5
(C/I)tot [multiple]	(DB):	14.5	16.9	14.8	17.4	13.5

CARRIER ID NUMBER	:	6	7	8	9	10
CARRIER TYPE	:	TV/FM	TV/FM	TV/FM	DIGITAL	DIGITAL
BANDWIDTH	(MHz):	26	26	16	54	36
DATA RATE	(MBPs):	N/A	N/A	N/A	90	60
NO. CHANNELS PER CARRIER	:	1	1	1	1	1
(C/I)up	(DB):	11.2	13.5	8.4	17.4	15.7
(C/I)dn	(DB):	30.7	35.2	18.7	25.0	31.3
(C/I)tot [1 carrier]	(DB):	11.2	13.5	8.0	16.8	15.6
(C/I)tot [multiple]	(DB):	11.2	13.5	8.0	16.8	15.6

CARRIER ID NUMBER	:	11	12	13	14	15
CARRIER TYPE	:	DIGITAL	DIGITAL	DIGITAL	DIGITAL	DIGITAL
BANDWIDTH	(MHz):	15	10	3.9	.14	54
DATA RATE	(MBPs):	6	12	1.544	.056	90
NO. CHANNELS PER CARRIER	:	1	1	1	1	1
(C/I)up	(DB):	22.2	22.1	22.3	19.7	17.1
(C/I)dn	(DB):	36.5	34.7	36.6	36.5	28.0
(C/I)tot [1 carrier]	(DB):	22.0	21.9	22.2	19.6	16.8
(C/I)tot [multiple]	(DB):	22.0	21.9	22.2	17.9	16.8

CARRIER ID NUMBER	:	16	17	18	19	20
CARRIER TYPE	:	DIGITAL	DIGITAL	DIGITAL	DIGITAL	DIGITAL
BANDWIDTH	(MHz):	54	36	36	54	16.6
DATA RATE	(MBPs):	90	60	60	80	8.8
NO. CHANNELS PER CARRIER	:	1	1	1	1	1
(C/I)up	(DB):	17.1	19.2	16.5	16.7	9.4
(C/I)dn	(DB):	32.0	31.3	31.3	34.0	28.9
(C/I)tot [1 carrier]	(DB):	17.0	18.9	16.3	16.7	9.4
(C/I)tot [multiple]	(DB):	17.0	18.9	16.3	16.7	9.4

TABLE A-4 (Cont'd)

INTERFERENCE INTO NEX "SMALL NETWORK" IN-ROUTE
CARRIERS FROM ADJACENT SATELLITE CARRIERS

CARRIER ID NUMBER	:	21	22	23	24	25
CARRIER TYPE	:	DIGITAL	DIGITAL	DIGITAL	DIGITAL	DIGITAL
BANDWIDTH	(MHz):	1.030	43.0	43	43	1.229
DATA RATE	(MBPs):	1.544	50	50	50	.512
NO. CHANNELS PER CARRIER	:	1	1	1	1	1
(C/I)up	(DB):	23.8	16.0	16.0	16.0	16.0
(C/I)dn	(DB):	35.9	30.4	30.4	27.4	42.6
(C/I)tot [1 carrier]	(DB):	23.5	15.8	15.8	15.7	16.0
(C/I)tot [multiple]	(DB):	23.5	15.8	15.8	15.7	16.0

CARRIER ID NUMBER	:	26	27	28	29	30
CARRIER TYPE	:	DIGITAL	SCPC/PSK	SCPC/PSK	SCPC/PSK	SCPC/PSK
BANDWIDTH	(MHz):	1.229	.039	.039	.064	.064
DATA RATE	(MBPs):	.512	.056	.056	.056	.056
NO. CHANNELS PER CARRIER	:	1	1	1	1	1
(C/I)up	(DB):	20.2	22.7	25.4	17.3	23.3
(C/I)dn	(DB):	30.9	42.0	42.0	35.5	41.5
(C/I)tot [1 carrier]	(DB):	19.9	22.7	25.3	17.3	23.3
(C/I)tot [multiple]	(DB):	19.9	15.4	18.0	12.1	18.1

CARRIER ID NUMBER	:	31	32	33
CARRIER TYPE	:	SCPC/FM	SCPC/FM	SCPC/FM
BANDWIDTH	(MHz):	.180	.018	.037
DATA RATE	(MBPs):	N/A	N/A	N/A
NO. CHANNELS PER CARRIER	:	1	1	1
(C/I)up	(DB):	22.4	30.4	34.2
(C/I)dn	(DB):	28.5	35.6	39.5
(C/I)tot [1 carrier]	(DB):	21.5	29.3	33.1
(C/I)tot [multiple]	(DB):	20.8	18.6	25.6

TABLE A-5

INTERFERENCE INTO ADJACENT SATELLITE CARRIERS
FROM NEX "SMALL NETWORK" OUT-ROUTE CARRIERS

CARRIER ID NUMBER	:	1	2	3	4	5
CARRIER TYPE	:	TV/FM	TV/FM	TV/FM	TV/FM	TV/FM
BANDWIDTH	(MHz):	36	36	36	36	22
DATA RATE	(MBPs):	N/A	N/A	N/A	N/A	N/A
NO. CHANNELS PER CARRIER	:	1	1	1	1	1
(C/I)up	(DB):	63.2	63.2	63.2	63.2	63.2
(C/I)dn	(DB):	51.2	53.9	46.2	48.9	37.8
(C/I)tot [1 carrier]	(DB):	51.0	53.4	46.1	48.8	37.8
(C/I)tot [multiple]	(DB):	29.8	32.3	25.0	27.6	18.8
BASEBAND S/I	(DB):	70	72.5	63.1	65.7000	50.7
BASEBAND NOISE	(pWOp):	N/A	N/A	N/A	N/A	N/A

CARRIER ID NUMBER	:	6	7	8	9	10
CARRIER TYPE	:	TV/FM	TV/FM	TV/FM	DIGITAL	DIGITAL
BANDWIDTH	(MHz):	26	26	16	54	36
DATA RATE	(MBPs):	N/A	N/A	N/A	90	60
NO. CHANNELS PER CARRIER	:	1	1	1	1	1
(C/I)up	(DB):	68.8	63.8	62.7	65.7	65.7
(C/I)dn	(DB):	39.5	40.7	38.9	56.5	48.5
(C/I)tot [1 carrier]	(DB):	39.5	40.7	38.9	56.0	48.4
(C/I)tot [multiple]	(DB):	19.8	21.0	21.3	33.1	27.3
BASEBAND S/I	(DB):	54.8	56	50.7	N/A	N/A
BASEBAND NOISE	(pWOp):	N/A	N/A	N/A	N/A	N/A

CARRIER ID NUMBER	:	11	12	13	14	15
CARRIER TYPE	:	DIGITAL	DIGITAL	DIGITAL	DIGITAL	DIGITAL
BANDWIDTH	(MHz):	15	10	3.9	.14	54
DATA RATE	(MBPs):	6	12	1.544	.056	90
NO. CHANNELS PER CARRIER	:	1	1	1	1	1
(C/I)up	(DB):	54.9	53.7	48.9	39.3	63.2
(C/I)dn	(DB):	38.5	39.5	32.5	20.4	50.2
(C/I)tot [1 carrier]	(DB):	38.4	39.4	32.4	20.3	50.0
(C/I)tot [multiple]	(DB):	21.1	23.8	20.9	20.3	27.1
BASEBAND S/I	(DB):	N/A	N/A	N/A	N/A	N/A
BASEBAND NOISE	(pWOp):	N/A	N/A	N/A	N/A	N/A

CARRIER ID NUMBER	:	16	17	18	19	20
CARRIER TYPE	:	DIGITAL	DIGITAL	DIGITAL	DIGITAL	DIGITAL
BANDWIDTH	(MHz):	54	36	36	54	16.6
DATA RATE	(MBPs):	90	60	60	80	8.8
NO. CHANNELS PER CARRIER	:	1	1	1	1	1
(C/I)up	(DB):	63.2	63.2	63.2	69.0	68.8
(C/I)dn	(DB):	46.2	48.9	46.2	49.8	39.5
(C/I)tot [1 carrier]	(DB):	46.1	48.8	46.1	49.8	39.5
(C/I)tot [multiple]	(DB):	23.2	27.6	25.0	26.9	21.7
BASEBAND S/I	(DB):	N/A	N/A	N/A	N/A	N/A
BASEBAND NOISE	(pWOp):	N/A	N/A	N/A	N/A	N/A

TABLE A-5 (Cont'd)

INTERFERENCE INTO ADJACENT SATELLITE CARRIERS
FROM NEX "SMALL NETWORK" OUT-ROUTE CARRIERS

CARRIER ID NUMBER	:	21	22	23	24	25
CARRIER TYPE	:	DIGITAL	DIGITAL	DIGITAL	DIGITAL	DIGITAL
BANDWIDTH	(MHz):	1.030	43.0	43	43	1.229
DATA RATE	(MBPs):	1.544	50	50	50	.512
NO. CHANNELS PER CARRIER	:	1	1	1	1	1
(C/I)up	(DB):	44.8	66.4	63.5	63.5	35.0
(C/I)dn	(DB):	30.8	50.6	47.9	50.9	22.6
(C/I)tot [1 carrier]	(DB):	30.7	50.5	47.8	50.7	22.4
(C/I)tot [multiple]	(DB):	24.9	28.6	25.9	28.8	15.9
BASEBAND S/I	(DB):	N/A	N/A	N/A	N/A	N/A
BASEBAND NOISE	(pWOp):	N/A	N/A	N/A	N/A	N/A

CARRIER ID NUMBER	:	26	27	28	29	30
CARRIER TYPE	:	DIGITAL	SCPC/PSK	SCPC/PSK	SCPC/PSK	SCPC/PSK
BANDWIDTH	(MHz):	1.229	.039	.039	.064	.064
DATA RATE	(MBPs):	.512	.056	.056	.056	.056
NO. CHANNELS PER CARRIER	:	1	1	1	1	1
(C/I)up	(DB):	47.0	43.1	43.1	44.6	38.6
(C/I)dn	(DB):	18.3	21.6	24.3	24.7	18.7
(C/I)tot [1 carrier]	(DB):	18.3	21.6	24.3	24.6	18.6
(C/I)tot [multiple]	(DB):	11.8	21.6	24.3	24.6	18.6
BASEBAND S/I	(DB):	N/A	N/A	N/A	N/A	N/A
BASEBAND NOISE	(pWOp):	N/A	N/A	N/A	N/A	N/A

CARRIER ID NUMBER	:	31	32	33
CARRIER TYPE	:	SCPC/FM	SCPC/FM	SCPC/FM
BANDWIDTH	(MHz):	.180	.018	.037
DATA RATE	(MBPs):	N/A	N/A	N/A
NO. CHANNELS PER CARRIER	:	1	1	1
(C/I)up	(DB):	35.6	31.4	35.0
(C/I)dn	(DB):	23.1	24.8	27.6
(C/I)tot [1 carrier]	(DB):	22.8	23.9	26.9
(C/I)tot [multiple]	(DB):	22.8	23.9	26.9
BASEBAND S/I	(DB):	62.3	64	78.1
BASEBAND NOISE	(pWOp):	579	397	15

TABLE A-6

INTERFERENCE INTO NEX "SMALL NETWORK" OUT-ROUTE CARRIERS FROM ADJACENT SATELLITE CARRIERS

CARRIER ID NUMBER	:	1	2	3	4	5
CARRIER TYPE	:	TV/FM	TV/FM	TV/FM	TV/FM	TV/FM
BANDWIDTH	(MHz):	36	36	36	36	22
DATA RATE	(MBPs):	N/A	N/A	N/A	N/A	N/A
NO. CHANNELS PER CARRIER	:	1	1	1	1	1
(C/I)up	(DB):	20.6	23.3	20.6	23.3	19.5
(C/I)dn	(DB):	22.4	22.4	27.4	27.4	22.4
(C/I)tot [1 carrier]	(DB):	18.4	19.8	19.8	21.9	17.7
(C/I)tot [multiple]	(DB):	18.4	19.8	19.8	21.9	17.7

CARRIER ID NUMBER	:	6	7	8	9	10
CARRIER TYPE	:	TV/FM	TV/FM	TV/FM	DIGITAL	DIGITAL
BANDWIDTH	(MHz):	26	26	16	54	36
DATA RATE	(MBPs):	N/A	N/A	N/A	90	60
NO. CHANNELS PER CARRIER	:	1	1	1	1	1
(C/I)up	(DB):	16.9	19.2	14.1	23.1	21.4
(C/I)dn	(DB):	28.4	32.9	16.4	22.7	29.0
(C/I)tot [1 carrier]	(DB):	16.6	19.0	12.1	19.9	20.7
(C/I)tot [multiple]	(DB):	16.6	19.0	12.1	19.9	20.7

CARRIER ID NUMBER	:	11	12	13	14	15
CARRIER TYPE	:	DIGITAL	DIGITAL	DIGITAL	DIGITAL	DIGITAL
BANDWIDTH	(MHz):	15	10	3.9	.14	54
DATA RATE	(MBPs):	6	12	1.544	.056	90
NO. CHANNELS PER CARRIER	:	1	1	1	1	1
(C/I)up	(DB):	27.9	27.8	28.0	25.4	22.8
(C/I)dn	(DB):	34.2	32.4	34.3	34.2	25.7
(C/I)tot [1 carrier]	(DB):	27.0	26.5	27.1	24.9	21.0
(C/I)tot [multiple]	(DB):	27.0	26.5	27.1	23.2	21.0

CARRIER ID NUMBER	:	16	17	18	19	20
CARRIER TYPE	:	DIGITAL	DIGITAL	DIGITAL	DIGITAL	DIGITAL
BANDWIDTH	(MHz):	54	36	36	54	16.6
DATA RATE	(MBPs):	90	60	60	80	8.8
NO. CHANNELS PER CARRIER	:	1	1	1	1	1
(C/I)up	(DB):	22.8	24.9	22.2	22.4	15.1
(C/I)dn	(DB):	29.7	29.0	29.0	31.7	26.6
(C/I)tot [1 carrier]	(DB):	22.0	23.5	21.4	22.0	14.8
(C/I)tot [multiple]	(DB):	22.0	23.5	21.4	22.0	14.8

TABLE A-6 (Cont'd)

INTERFERENCE INTO NEX "SMALL NETWORK" OUT-ROUTE
CARRIERS FROM ADJACENT SATELLITE CARRIERS

CARRIER ID NUMBER	:	21	22	23	24	25
CARRIER TYPE	:	DIGITAL	DIGITAL	DIGITAL	DIGITAL	DIGITAL
BANDWIDTH	(MHz):	1.030	43.0	43	43	1.229
DATA RATE	(MBPs):	1.544	50	50	50	.512
NO. CHANNELS PER CARRIER	:	1	1	1	1	1
(C/I)up	(DB):	29.5	21.7	21.7	21.7	21.7
(C/I)dn	(DB):	33.6	28.1	28.1	25.1	40.3
(C/I)tot [1 carrier]	(DB):	28.0	20.8	20.8	20.0	21.7
(C/I)tot [multiple]	(DB):	28.0	20.8	20.8	20.0	21.7

CARRIER ID NUMBER	:	26	27	28	29	30
CARRIER TYPE	:	DIGITAL	SCPC/PSK	SCPC/PSK	SCPC/PSK	SCPC/PSK
BANDWIDTH	(MHz):	1.229	.039	.039	.064	.064
DATA RATE	(MBPs):	.512	.056	.056	.056	.056
NO. CHANNELS PER CARRIER	:	1	1	1	1	1
(C/I)up	(DB):	25.9	28.4	31.1	23.0	29.0
(C/I)dn	(DB):	28.6	39.7	39.7	33.2	39.2
(C/I)tot [1 carrier]	(DB):	24.1	28.1	30.6	22.6	28.6
(C/I)tot [multiple]	(DB):	24.1	20.8	23.3	17.5	23.5

CARRIER ID NUMBER	:	31	32	33
CARRIER TYPE	:	SCPC/FM	SCPC/FM	SCPC/FM
BANDWIDTH	(MHz):	.180	.018	.037
DATA RATE	(MBPs):	N/A	N/A	N/A
NO. CHANNELS PER CARRIER	:	1	1	1
(C/I)up	(DB):	28.1	36.1	39.9
(C/I)dn	(DB):	26.2	33.3	37.2
(C/I)tot [1 carrier]	(DB):	24.1	31.5	35.4
(C/I)tot [multiple]	(DB):	23.4	20.9	27.8

2. C-Band Interference Analysis.

The C-Band interference model, when applied in conjunction with the SpotNet C-Band characteristics, produces the results contained in Tables A-7 through A-9. Table A-7 contains the input parameters used in the model, including the SpotNet C-Band characteristics (lines 61-64), and the characteristics of all other space stations (lines 1-60). Table A-8 summarizes the thermal noise characteristics of each carrier. Table A-9 summarizes the input assumptions made and contains footnotes applicable to the preceding tables. Table A-11 summarizes the interference interactions between each pair of carriers. Since there are 64 carriers, there are 4,096 possible interactions.

The table details the number of dB by which an interfering signal exceeds the interference criterion of the desired signal. A blank entry for any interaction indicates that the interference criterion is met. An asterisk indicates that the interference exceeds the criterion by more than 9.5 dB. As can be seen in Table A-10, SpotNet is a relatively low-interference C-Band satellite system. This is due to an RF system and signal design that is highly compatible with existing satellites. Those systems having the most interference entries include satellites that are copolarized with the SpotNet system. As stated in OST Report FCC/OST R83-2, polarization interleaving between satellites is necessary for achievement of 2° satellite spacing.

NEX currently plans to use the "Hughes/Western Union" polarization/channelization plan for the C-Band portions of the NEX satellite system. Depending upon the final assignment of other satellites to adjacent orbital locations, it may be desirable, from the standpoint of interference potential, to use the complementary "RCA" polarization/channelization plan. This situation currently occurs, for example, at 101° W.L. between the Canadian Anik D-1 satellite (104.5° W.L.) and the Western Union Westar 4 satellite (98.5° W.L.).

Table A-11 presents the results of an analysis of the potential interference interactions between the SpotNet C-Band subsystem using the "RCA" polarization/channelization scheme and all other authorized satellites. The same information presented in Table A-10 is presented in Table A-11, with the exception that the polarizations of SpotNet have been reversed. Instead of being vertically polarized, the uplink is polarized horizontally. The downlink polarization is similarly reversed.

The results of these analysis show that SpotNet is relatively compatible both in the complementary polarization scheme and in its primary polarizations. In particular, it can be seen that those satellites that are shown in Table A-11 to have some potential interference interactions with SpotNet are relatively interference-free when operating adjacent to the complementary-polarized SpotNet in Table A-10.

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CARRIER	COMPANY	TYPE	RF BAND WIDTH (MHZ)	NO. OF CHAN	CODE RATE/ MOD. INDEX	BOT MOD. FREQ. (MHZ)	TOP MOD. FREQ. (MHZ)	AVE. TALKER LEVEL (DBMO)	CLEAR PREEMPH NOISE WEIGHTS (DB)	PHASE	DATA RATE (MBPS)	CHAN. SPACE (MHZ)	TRANSPONDER FREQUENCY UP (GHZ)	TRANSPONDER FREQUENCY DN (GHZ)	U P	D N	EARTH STATION TRANSMITTER POWR (DBW)	EARTH STATION TRANSMITTER DIAM (M)	EARTH STATION TRANSMITTER GAIN (DB)	SATELLITE RECEIVER GAIN (DB)	SATELLITE RECEIVER TEMP (K)	SAT EIRP (DBW)	EARTH STATION RECEIVER DIAM (M)	EARTH STATION RECEIVER GAIN (DB)	EARTH STATION RECEIVER TEMP (K)
1	ALAS	4	0.029	800	2.824	0.000	0.003	0.0	16.0	0	0.000	0.045	6.145	3.920	0	1	6.6	5.0	47.3	28.2	750.	5.7	15.0	52.4	100
2	ALAS	4	0.029	800	2.824	0.000	0.003	0.0	16.0	0	0.000	0.045	6.145	3.920	0	1	8.2	15.0	57.8	28.2	750.	7.2	5.0	44.5	120
3	ASC	0	45.000	1800	0.308	0.060	7.860	-15.0	10.3	0	0.000	0.000	6.145	3.920	0	1	25.0	13.0	56.0	25.0	800.	34.0	13.0	52.0	80
4	ASC	0	12.000	472	0.900	0.012	1.550	20.0	0.0	0	0.000	12.000	6.145	3.920	0	1	10.7	10.0	53.5	25.0	800.	22.0	10.0	50.5	56
5	ASC	1	32.000	1	2.560	0.025	4.200	0.0	12.8	0	0.000	0.000	6.145	3.920	0	1	27.5	10.0	53.5	25.0	800.	34.0	5.0	44.5	125
6	ASC	2	36.000	1	0.000	0.000	0.000	0.0	0.0	4	64.000	0.000	6.145	3.920	0	1	24.5	10.0	53.5	25.0	800.	33.0	11.0	51.5	71
7	ASC	2	9.600	1	0.000	0.000	0.000	0.0	0.0	4	7.700	0.000	6.145	3.920	0	1	24.5	10.0	53.5	25.0	800.	33.0	3.0	39.5	150
8	ASC	2	3.750	8	0.000	0.000	0.000	0.0	0.0	4	4.000	4.000	6.145	3.920	0	1	11.5	10.0	53.5	25.0	800.	24.0	10.0	50.5	87
9	ASC	2	1.800	32	0.000	0.000	0.000	0.0	0.0	4	1.544	1.3008	6.145	3.920	0	1	4.7	10.0	53.5	25.0	800.	14.8	10.0	50.5	89
10	ASC	2	8.100	32	0.000	0.000	0.000	0.0	0.0	4	1.544	1.3008	6.145	3.920	0	1	3.1	10.0	53.5	25.0	800.	14.1	10.0	50.5	56
11	ASC	3	0.040	160	0.000	0.000	0.000	0.0	0.0	4	0.056	0.2008	6.145	3.920	0	1	1.1	5.0	47.3	25.0	800.	7.5	5.0	44.5	125
12	ASC	3	0.040	620	0.000	0.000	0.000	0.0	0.0	4	0.056	0.0488	6.145	3.920	0	1	9.5	10.0	53.5	25.0	800.	1.0	10.0	50.5	89
13	AT&T	5	34.000	7800	0.000	1.000	17.000	-22.0	0.0	0	0.000	0.000	6.145	3.920	1	1	19.4	30.0	62.4	24.5	900.	20.6	30.0	59.4	54
14	AT&T	5	30.000	6000	0.000	1.000	15.000	22.0	0.0	0	0.000	0.000	6.145	3.920	1	1	27.6	13.0	55.1	24.5	900.	29.8	12.0	52.5	71
15	AT&T	01	36.000	1800	0.451	0.564	8.524	20.0	0.0	0	0.000	0.000	6.145	3.920	1	1	28.3	30.0	62.4	24.5	900.	35.0	30.0	59.4	54
16	AT&T	1	36.000	1	2.571	0.025	4.200	0.0	12.8	0	0.000	0.000	6.145	3.920	1	1	27.5	10.0	53.5	24.5	900.	35.0	7.0	47.5	125
17	AT&T	2	36.000	1	0.000	0.000	0.000	0.0	0.0	4	60.000	0.000	6.145	3.920	1	1	27.0	12.0	55.1	24.5	900.	44.2	12.0	52.5	71
18	AT&T	2	36.000	1	0.000	0.000	0.000	0.0	0.0	8	90.000	0.000	6.145	3.920	1	1	21.6	30.0	62.4	24.5	900.	33.0	30.0	59.4	54
19	AT&T	2	1.060	24	0.000	0.000	0.000	0.0	0.0	4	1.544	1.3008	6.145	3.920	1	1	11.5	12.0	55.1	24.5	900.	15.7	12.0	52.5	71
20	AT&T	2	1.060	24	0.000	0.000	0.000	0.0	0.0	4	1.544	1.3008	6.145	3.920	1	1	13.1	10.0	53.5	24.5	900.	15.7	10.0	50.5	71
21	AT&T	2	1.853	5	0.000	0.000	0.000	0.0	0.0	4	1.544	5.000	6.145	3.920	1	1	13.5	10.0	53.5	24.5	900.	24.6	3.0	39.5	130
22	RCA	5	34.000	5820	0.000	1.000	17.000	21.0	7.8	0	0.000	0.000	6.145	3.920	0	1	30.0	13.0	56.0	24.0	750.	30.0	13.0	54.0	80
23	RCA	0	36.000	2892	0.323	0.012	12.388	18.0	11.1	0	0.000	0.000	6.145	3.920	0	1	25.9	13.0	56.0	24.0	750.	34.0	13.0	52.0	80
24	RCA	0	36.000	1932	0.385	0.012	8.120	15.0	10.3	0	0.000	0.000	6.145	3.920	0	1	25.0	13.0	56.0	24.0	750.	34.0	11.0	52.0	80
25	RCA	0	20.700	432	1.501	0.012	1.796	-15.0	0.0	0	0.000	18.000	6.145	3.920	0	1	13.9	13.0	56.0	24.0	750.	25.5	13.0	52.0	80
26	RCA	1	36.000	1	2.560	0.025	4.200	0.0	12.8	0	0.000	0.000	6.145	3.920	0	1	25.0	13.0	56.0	24.0	750.	34.0	13.0	52.0	80
27	RCA	1	36.000	1	2.560	0.025	4.200	0.0	12.8	0	0.000	0.000	6.145	3.920	0	1	26.2	11.0	54.3	24.0	750.	34.0	11.0	51.3	80
28	RCA	1	18.000	1	1.500	0.025	4.200	0.0	12.8	0	0.000	0.000	6.145	3.920	0	1	22.7	11.0	54.3	24.0	750.	33.0	7.0	47.5	80
29	RCA	1	36.000	1	2.560	0.025	4.200	0.0	12.8	0	0.000	0.000	6.145	3.920	0	1	27.5	10.0	53.5	24.0	750.	34.0	4.5	44.0	125
30	RCA	1	36.000	1	2.560	0.025	4.200	0.0	12.8	0	0.000	0.000	6.145	3.920	0	1	27.5	10.0	53.5	24.0	750.	34.0	7.0	47.5	125
31	RCA	1	18.000	2	1.500	0.025	4.200	0.0	12.8	0	0.000	16.000	6.145	3.920	0	1	21.5	10.0	53.5	24.0	750.	30.0	4.5	44.0	125
32	RCA	1	18.000	2	1.500	0.025	4.200	0.0	12.8	0	0.000	16.000	6.145	3.920	0	1	21.5	10.0	53.5	24.0	750.	30.0	10.0	50.5	112
33	RCA	2	36.000	1	0.000	0.000	0.000	0.0	0.0	4	60.000	0.000	6.145	3.920	0	1	26.7	11.0	54.3	24.0	750.	34.0	11.0	51.3	107
34	RCA	2	16.600	1	0.000	0.000	0.000	0.0	0.0	2	8.800	0.000	6.145	3.920	0	1	22.5	13.0	56.0	24.0	750.	34.0	5.1	39.5	130
35	RCA	2	1.030	32	0.000	0.000	0.000	0.0	0.0	4	1.544	1.3008	6.145	3.920	0	1	7.9	11.0	54.3	24.0	750.	15.0	11.0	51.3	107
36	RCA	3	0.064	100	0.000	0.000	0.000	0.0	0.0	2	0.064	0.2008	6.145	3.920	0	1	7.6	5.0	47.4	24.0	750.	9.0	5.0	44.5	125
37	RCA	4	0.037	620	4.412	0.000	0.003	0.0	25.8	0	0.000	0.0488	6.145	3.920	0	1	-1.0	10.0	53.5	24.0	750.	0.0	10.0	50.5	112
38	RCA	6	0.450	80	0.000	0.000	0.000	0.0	13.7	2	0.010	0.450	6.145	3.920	0	1	19.8	1.4	36.2	24.0	750.	10.0	1.4	32.8	120
39	W.U.	0	36.000	1500	0.527	0.060	6.748	-15.0	0.0	0	0.000	0.000	6.145	3.920	1	0	23.2	15.0	57.8	25.0	800.	34.0	15.0	54.7	54
40	W.U.	0	4.500	60	2.053	0.060	0.300	-15.0	0.0	0	0.000	5.000	6.145	3.920	1	0	2.2	15.0	57.8	25.0	800.	18.0	15.0	54.7	54
41	W.U.	1	36.000	1	2.619	0.025	4.200	0.0	12.8	0	0.000	0.000	6.145	3.920	1	0	25.1	11.0	54.3	25.0	800.	34.0	11.0	51.3	54
42	W.U.	2	36.000	1	0.000	0.000	0.000	0.0	0.0	4	62.000	0.000	6.145	3.920	1	0	20.2	15.0	57.8	25.0	800.	33.0	15.0	54.7	54
43	NPR	4	0.180	21	5.000	0.000	0.015	0.0	29.0	0	0.000	PLAN	6.145	3.920	1	0	12.0	4.6	46.5	25.0	800.	16.5	4.6	43.5	125
44	MUZA	4	0.120	7	3.000	0.000	0.015	0.0	29.0	0	0.000	PLAN	6.145	3.920	1	0	10.7	10.0	53.5	25.0	800.	22.0	1.2	31.5	230
45	A.P.	3	0.038	56	0.000	0.000	0.000	0.0	0.0	4	0.056	0.5008	6.145	3.920	1	0	0.5	10.0	53.5	25.0	800.	12.0	3.0	39.5	148
46	A.P.	3	0.174	6	0.000	0.000	0.000	0.0	0.0	4	0.256	5.0008	6.145	3.920	1	0	6.5	10.0	53.5	25.0	800.	18.6	3.0	39.5	148
47	MDG	4	0.200	6	5.667	0.000	0.015	0.0	29.0	0	0.000	PLAN	6.145	3.920	1	0	6.7	11.0	54.3	25.0	800.	19.0	1.8	34.5	140
48	FOU	6	4.915	6	0.000	0.000	0.000	0.0	24.1	2	0.010	6.000	6.145	3.920	1	0	4.8	18.3	58.2	25.0	800.	20.0	0.6	26.0	120
49	HUGH	0	36.000	960	1.097	0.060	4.028	-15.0	0.0	0	0.000	0.000	6.145	3.920	1	0	27.0	10.0	54.0	24.8	800.	34.0	10.0	50.7	125
50	HUGH	1	36.000	1	2.619	0.020	4.200	0.0	12.8	0	0.000	0.000	6.145	3.920	1	0	27.0	10.0	54.0	24.8	800.	34.0	4.5	44.0	125
51	HUGH	2	4.000	4	0.000	0.000	0.000	0.0	0.0	4	6.400	8.000	6.145	3.920	1	0	11.0	10.0	54.0	24.8	800.	24.0	10.0	50.7	125
52	HUGH	4	0.020	398	5.600	0.000	0.003	0.0	23.5	0	0.000	0.0808	6.145	3.920	1	0	2.5	4.5	47.1	24.8	800.	3.7	4.5	44.0	125
53	BPC	0	36.000	1872	0.407	0.012	7.868	15.0	10.3	0	0.000	0.000	6.145	3.920	1	0	27.0	10.0	54.0	26.0	750.	34.0	10.0	50.5	112
54	BPC	0	17.500	432	1.019	0.564	2.074	-15.0	0.0	0	0.000	18.000	6.145	3.920	1	0	19.0	10.0	54.0	26.0	750.	30.0	10.0	50.5	112
55	BPC	1	36.000	1	2.690	0.025	4.200	0.0	13.0	0	0.000	0.000	6.145	3.920	1	0	27.0	10.0	54.0	26.0	750.	34.0	7.0	47.5	120
56	BPC	1	36.000	1	2.690	0.025	4.200	0.0	13.0	0	0.000	0.000	6.145	3.920	1	0	27.0	10.0	54.0	26.0	750.	34.0	5.0	45.0	120
57	BPCW	0	36.000	1872	0.407	0.012	7.868	15.0	10.3	0	0.000	40.000	6.145	3.920	0	1	15.2	13.0	56.3	26.0	750.	32.0	13.0	52.0	80
58	BPCW	1	36.000	2	2.690	0.025	4.200	0.0	13.0	0	0.000	40.000	6.145	3.920	0	1	17.5	10.0	54.0	26.0	750.	32.0	7.0	47.5	120
59	BPCW	1	36.000	2	2.690	0.025	4.200	0.0	13.0	0	0.000	40.000	6.145	3.920	0	1	17.5	10.0	54.0	26.0	750.	32.0	5.0	45.0	120
60	BPCW	2	72.000	1	0.000	0.000	0.000	0.0	0.0	4	125.000	0.000	6.145	3.920	0	1	24.0	10.0	54.0	26.0	750.	35.7	10.0	50.5	112
61	MEX	0	36.000	960	1.097	0.060	4.028	-15.0	0.0	0	0.000	0.000	6.145	3.920	1	0	27.0	10.0	54.0	24.8	800.	34.0	10.0	50.7	125
62	MEX	1	36.000	1	2.619	0.020	4.200	0.0	12.8	0	0.000	0.000	6.145	3.920	1	0	27.0	10.0	54.0	24.8	800.	34.0	4.5	44.0	125
63	MEX	2	4.000	4	0.000	0.000	0.000	0.0	0.0	4	6.400	8.000	6.145	3.920	1	0	11.0	10.0	54.0	24.8	800.	24.0	10.0	50.7	125
64	MEX	4	0.020	398	5.600	0.000	0.003	0.0	23.5	0	0.000	0.0808	6.145	3.920	1	0	-2.5	4.5	47.1	24.8	800.	3.7	4.5	44.0	125

TABLE A-7

INPUT PARAMETERS

THERMAL NOISE SUMMARY

CARRIER	LUMINARY	EARTH TO SPACE POINT EIRP (DBW)	ING SPACE LOSS (DB)	OSS RCV G/T (DB)	(DB/K)	SPACE TO EARTH POINT EIRP (DBW)	ING SPACE LOSS (DB)	OSS RCV G/T (DB)	(DB/K)	C/KT (DB/HZ) UP	DN	TOTAL	C/N (DB) UP	DN	TOTAL	TOTAL (DEGK)	DRAMA S/N (DB)	NOISE EB/KT (DB)	SINGLE ENTRY TERMINAL (DEGK)	S/I (DB)	INTERFERENCE OBJECTIVE C/I (DB)
1	ALAS	40.7	0.0	199.8	0.6	5.7	0.2	196.2	35.4	68.9	61.9	61.1	24.3	17.3	16.5	4185.	53.8				24.7
2	ALAS	49.6	0.3	199.8	0.6	7.2	0.0	196.2	35.7	77.5	64.1	63.1	32.9	18.7	18.5	2651.	55.8				32.4
3	ASC	81.0	0.3	199.8	4.0	34.0	0.2	196.2	33.0	105.5	99.2	98.1	30.0	21.7	20.8	1660.	54.4		600.	62.2	
4	ASC	64.2	0.3	199.8	4.0	22.0	0.2	196.2	33.0	88.7	87.2	84.9	17.9	16.4	14.1	10196.	49.9		600.	62.2	
5	ASC	81.0	0.3	199.8	4.0	34.0	0.0	196.2	33.5	105.5	89.9	89.8	30.4	14.9	14.8		52.0			53.2	22.0
6	ASC	78.0	0.3	199.8	4.0	33.0	0.2	196.2	33.0	102.5	98.2	96.8	26.9	22.6	21.2			18.7			28.0
7	ASC	78.0	0.3	199.8	4.0	33.0	0.0	196.2	18.4	102.5	83.8	83.7	32.6	13.9	13.9			14.8			28.0
8	ASC	65.0	0.3	199.8	4.0	23.0	0.2	196.2	33.0	89.5	84.2	84.5	23.7	20.5	18.8			18.5			28.0
9	ASC	57.2	0.3	199.8	4.0	14.8	0.2	196.2	31.0	81.7	78.0	76.5	21.3	17.6	16.0			14.6			27.1
10	ASC	56.6	0.3	199.8	4.0	14.1	0.2	196.2	33.0	81.1	79.3	77.1	20.7	18.9	16.7			17.3			27.1
11	ASC	48.4	0.0	199.8	4.0	7.5	0.0	196.2	23.5	73.2	63.4	63.0	22.1	17.4	17.0			15.5			24.0
12	ASC	44.0	0.3	199.8	4.0	1.0	0.2	196.2	31.0	68.5	64.2	62.8	22.4	18.2	16.8			15.3			24.0
13	AT&T	81.7	0.5	199.8	5.0	28.6	0.2	196.2	42.0	66.0	63.9	61.8	30.0	27.8	25.8	7267.	51.4		3548.	54.5	
14	AT&T	82.7	0.3	199.8	5.0	29.8	0.1	196.2	34.0	68.4	58.3	57.9	32.4	23.3	21.9	17846.	47.5		3548.	54.5	
15	AT&T	90.6	0.5	199.8	5.0	35.0	0.2	196.2	42.0	111.9	109.2	107.9	38.3	33.6	32.3	1443.	57.8		600.	62.2	
16	AT&T	81.0	0.3	199.8	5.0	35.0	0.1	196.2	24.5	104.5	93.8	93.5	28.9	18.3	17.9		55.2			58.2	27.0
17	AT&T	82.1	0.3	199.8	5.0	34.2	0.1	196.2	34.0	105.6	100.5	99.3	30.0	24.9	23.7			21.5			28.0
18	AT&T	83.9	0.5	199.8	5.0	34.0	0.2	196.2	42.0	107.2	107.2	104.2	31.4	31.4	28.4			24.4			33.2
19	AT&T	66.4	0.3	199.8	5.0	15.7	0.1	196.2	34.0	90.1	82.0	81.4	29.8	21.7	21.1			19.5			27.1
20	AT&T	66.6	0.3	199.8	5.0	15.7	0.1	196.2	32.0	90.1	80.0	79.6	29.8	19.7	19.3			17.7			25.5
21	AT&T	67.0	0.3	199.8	5.0	24.0	0.1	196.2	18.4	90.5	74.7	74.5	27.8	12.0	11.9			12.7			24.4
22	RCA	74.0	0.3	199.8	4.8	30.0	0.2	196.2	34.0	60.1	58.5	56.2	34.1	22.5	20.2	5477.	52.6		600.	62.2	
23	RCA	81.0	0.3	199.8	4.8	34.0	0.2	196.2	33.0	104.7	99.2	98.1	29.2	24.6	22.5	3659.	54.4		600.	62.2	
24	RCA	81.0	0.3	199.8	4.8	34.0	0.2	196.2	33.0	104.7	99.2	98.1	29.2	23.6	22.5	4127.	53.8		600.	62.2	
25	RCA	69.9	0.3	199.8	4.8	25.5	0.2	196.2	31.0	93.6	90.7	88.9	28.5	17.5	15.7	5433.	52.7		600.	62.2	
26	RCA	81.0	0.3	199.8	4.8	34.0	0.2	196.2	33.0	104.7	99.2	98.1	29.2	24.6	22.5		59.8			67.0	15.8
27	RCA	81.0	0.3	199.8	4.8	34.0	0.2	196.2	32.3	104.7	98.5	97.6	29.2	23.9	22.0		59.1			67.0	15.8
28	RCA	77.0	0.3	199.8	4.8	33.0	0.1	196.2	28.5	100.7	93.8	93.0	28.2	21.2	20.4		58.5			65.5	19.0
29	RCA	81.0	0.3	199.8	4.8	34.0	0.0	196.2	23.0	104.7	89.4	89.3	29.2	13.9	13.7		54.0			51.2	22.0
30	RCA	81.0	0.3	199.8	4.8	34.0	0.1	196.2	26.5	104.7	92.8	92.6	29.2	17.3	17.0		54.1			51.2	22.0
31	RCA	75.0	0.3	199.8	4.8	30.0	0.0	196.2	23.0	98.7	85.4	85.2	26.2	12.9	12.7		41.8			48.5	22.0
32	RCA	75.0	0.3	199.8	4.8	30.0	0.2	196.2	30.0	98.7	92.2	91.3	26.2	19.7	18.8		49.9			48.5	22.0
33	RCA	81.0	0.3	199.8	4.8	34.0	0.2	196.2	31.0	104.7	97.2	96.5	29.2	21.6	20.9			18.7			28.0
34	RCA	78.5	0.3	199.8	4.8	34.0	0.0	196.2	18.4	102.2	84.8	84.7	30.0	12.6	12.5			15.3			28.0
35	RCA	62.2	0.3	199.8	4.8	15.0	0.2	196.2	31.0	85.9	78.2	77.5	25.8	18.1	17.4			15.6			27.1
36	RCA	55.0	0.0	199.8	4.8	9.0	0.0	196.2	23.5	79.0	64.9	64.8	31.0	16.9	16.7			16.7			21.5
37	RCA	52.5	0.3	199.8	4.8	0.0	0.2	196.2	30.0	76.2	62.2	62.0	30.4	16.5	16.4	175.	67.6				23.2
38	RCA	56.0	0.0	199.8	4.8	10.0	0.0	196.2	12.0	80.0	54.4	54.4	23.5	2.1	2.1			14.6			11.0
39	W.U.	81.0	0.3	199.8	4.0	34.0	0.2	196.2	37.4	105.5	103.6	101.4	29.9	28.0	25.8	8567.	50.7		600.	62.2	
40	W.U.	60.0	0.3	199.8	4.0	18.0	0.2	196.2	37.4	84.5	82.6	82.2	27.9	21.0	16.2	9580.	54.5		600.	62.2	
41	W.U.	79.4	0.3	199.8	4.0	34.0	0.2	196.2	34.0	103.9	100.2	98.6	28.3	24.6	23.1		60.6			67.0	15.6
42	W.U.	78.0	0.3	199.8	4.0	33.0	0.2	196.2	37.4	102.5	102.6	99.5	26.9	27.0	23.9			21.6			28.0
43	NPR	58.5	0.0	199.8	4.0	16.5	0.0	196.2	22.5	83.3	71.4	71.2	30.7	18.9	18.6	39.	74.1				24.3
44	NWZA	64.2	0.3	199.8	4.0	22.0	0.0	196.2	7.9	88.7	62.3	62.3	37.9	11.5	11.5	859.	60.8				3.1
45	A.P.	51.0	0.3	199.8	4.0	12.0	0.0	196.2	17.8	77.5	62.2	62.1	31.7	16.4	16.3			14.6			11.4
46	A.P.	60.0	0.3	199.8	4.0	18.6	0.0	196.2	17.8	84.5	68.8	68.7	32.1	16.4	16.3			14.6			24.0
47	NBS	61.0	0.3	199.8	4.0	19.0	0.0	196.2	12.8	85.5	64.2	64.2	32.5	11.2	11.2	150.	68.2				22.0
48	EBU	63.0	0.3	199.8	4.0	20.0	0.0	196.2	5.2	87.5	57.6	57.6	30.6	-9.3	-9.3			17.8			0.6
49	HAWN	81.0	0.3	199.8	4.2	34.0	0.2	196.2	29.7	105.3	95.9	95.5	29.7	20.4	19.9	4989.	53.0		600.	62.2	
50	HAWN	81.0	0.3	199.8	4.2	34.0	0.0	196.2	23.0	105.3	89.4	89.3	29.7	13.9	13.8		54.3			54.4	22.0
51	HAWN	65.0	0.3	199.8	4.2	24.0	0.2	196.2	29.7	89.3	85.9	84.3	23.2	19.9	18.3			16.2			28.0
52	HAWN	44.6	0.0	199.8	4.2	3.7	0.0	196.2	23.0	69.2	59.1	58.7	26.2	16.1	15.7	195.	64.0				21.2
53	SPC	81.0	0.3	199.8	3.8	34.0	0.2	196.2	30.0	104.7	96.2	95.8	31.2	20.6	20.3	6032.	52.2		600.	62.2	
54	SPC	73.0	0.3	199.8	3.8	28.0	0.2	196.2	30.0	98.7	93.2	91.3	26.3	19.8	18.9	6710.	51.7		600.	62.2	
55	SPC	81.0	0.3	199.8	3.8	34.0	0.1	196.2	26.7	106.7	93.0	92.8	31.2	17.4	17.1		55.1			54.6	22.0
56	SPC	81.0	0.3	199.8	3.8	34.0	0.0	196.2	24.2	106.7	90.6	90.5	31.2	15.0	14.9		54.0			54.6	22.0
57	SPCM	71.5	0.3	199.8	3.8	27.0	0.2	196.2	31.0	97.2	97.2	94.2	31.2	21.6	18.6	1180.	60.6		600.	62.2	
58	SPCM	71.5	0.3	199.8	3.8	27.0	0.1	196.2	26.7	97.2	91.0	90.1	31.2	15.4	14.5		50.5			54.6	22.0
59	SPCM	71.5	0.3	199.8	3.8	27.0	0.0	196.2	24.2	97.2	88.6	88.1	31.2	13.0	12.5		50.5			54.6	22.0
60	SPCM	78.0	0.3	199.8	3.8	32.0	0.2	196.2	30.0	103.7	97.9	96.9	35.2	19.3	18.1	17.9					28.0
61	MEX	81.0	0.3	199.8	4.2	34.0	0.2	196.2	29.7	105.3	95.9	95.5	29.7	20.4	19.9	4989.	53.0		600.	62.2	
62	MEX	81.0	0.3	199.8	4.2	34.0	0.0	196.2	23.0	105.3	89.4	89.3	29.7	13.9	13.8		54.3			54.4	22.0
63	MEX	45.0	0.3	199.8	4.2	24.0	0.2	196.2	29.7	89.3	85.9	84.3	23.2	19.9	18.3			16.2			28.0
64	MEX	44.6	0.0	199.8	4.2	3.7	0.0	196.2	23.0	69.2	59.1	58.7	26.2	16.1	15.7	195.	64.0				21.2

TABLE A-8

THERMAL NOISE SUMMARY

INPUT PARAMETERS

SIGNAL TYPE INDEX

0 = FDM/FM
1 = TV/FM
2 = DIGITAL
3 = SCPC/PSK
4 = SCPC/FM
5 = CSSB/AM
6 = SS/PSK

POLARIZATION TYPE INDEX

0 = HORIZONTAL
1 = VERTICAL
2 = 20 DEG CANTED HORIZONTAL
3 = 20 DEG CANTED VERTICAL
4 = LEFT-HAND CIRCULAR
5 = RIGHT-HAND CIRCULAR

POLARIZATION ISOLATION MATRIX

DESIRED SIGNAL	INTERFERING SIGNAL 0	1	2	3	4	5
0	0.0	10.0	0.0	6.9	3.0	3.0
1	10.0	0.0	6.9	0.0	3.0	3.0
2	0.0	6.9	0.0	10.0	3.0	3.0
3	6.9	0.0	10.0	0.0	3.0	3.0
4	1.5	1.5	1.5	1.5	0.0	6.0
5	1.5	1.5	1.5	1.5	6.0	0.0

SPECTRA ASSUMED FOR INTERFERENCE INTO SCPC & PSK

TV/FM: 1.2 MHZ SPREADING ONLY

FDM/FM: GAUSSIAN, EXCEPT FOR THOSE MARKED WITH "1" UNDER SIGNAL TYPE

* INDICATES SCPC AND SMALL FDMA CARRIERS WHOSE TRANSPONDER FREQUENCY PLANS AVOID +- 1.5 MHZ AT THE TRANSPONDER CENTER.

"PLAN" UNDER CHANNEL SPACING INDICATES A FIXED FREQUENCY PLAN.

THERMAL NOISE SUMMARY

+ POINTING LOSS INCLUDED IN THERMAL NOISE ONLY, NOT IN INTERFERENCE CALCULATIONS.

* FREE SPACE LOSS (10 DEG ELEV. ANG.) & ATMOSPHERIC LOSSES
= 199.6 + 0.2 DB (UP LINK)
= 196.1 + 0.1 DB (DOWN LINK)

- FOR TV/FM, INDICATES THE OBJECTIVE'S EQUIVALENT LEVEL FOR INTERFERENCE FROM ITSELF. FOR COMPARISON ONLY, NOT USED AS THE SINGLE ENTRY OBJECTIVE.

TABLE A-9

FOOTNOTES

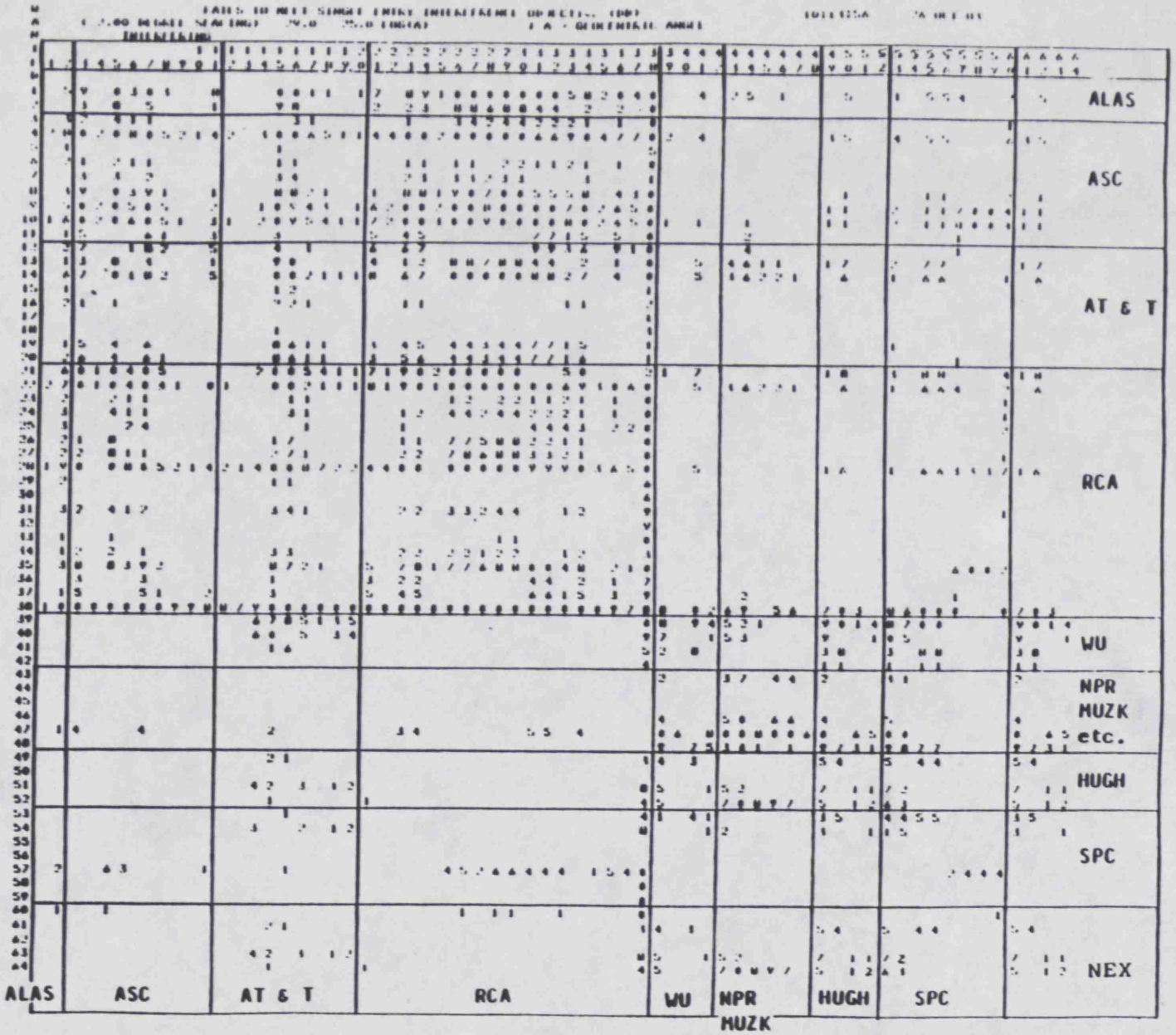


TABLE A-10

POTENTIAL INTERFERENCE SITUATIONS
("HUGHES/WESTAR" POLARIZATION)

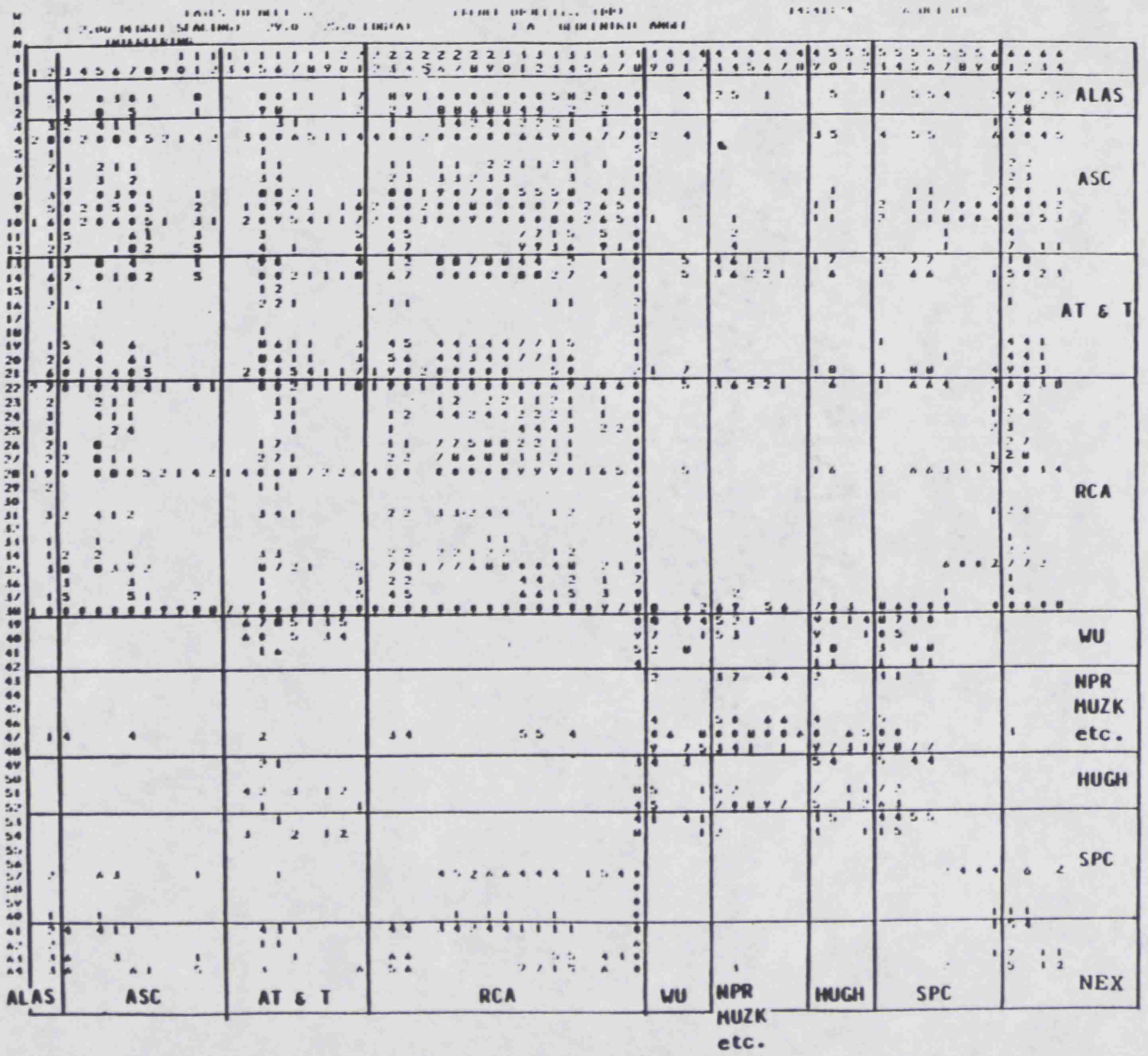


TABLE A-11

POTENTIAL INTERFERENCE SITUATIONS
("RCA" POLARIZATION)

EXHIBIT A

Financial Qualifications Materials

BURLINGTON NORTHERN INC.

GERALD GRINSTEIN
Vice Chairman

777 Main Street
Ft. Worth, Texas 76102
(817) 878-2272

August 20, 1987

Mr. Clay T. Whitehead
National Exchange, Inc.
1505 Planning Research Drive
Suite 220
McLean, Virginia 22102

Dear Mr. Whitehead:

The attached financial statements show Burlington Northern, Inc. (BNI) assets of $10.7 billion and stockholders' equity of $3.5 billion. In addition, BNI has credit lines of $1.35 billion. Annual funds from operations exceeded $1.2 billion for 1986. These available funds are well in excess of the $563.2 million required over six years for the National Exchange satellite program.

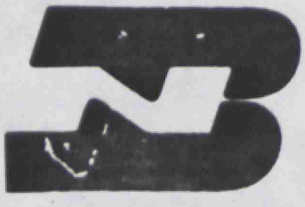
BNI has reviewed National Exchange's FCC application and its business plans for satellite system construction and operation. BNI intends to provide the necessary financial support for that satellite project and other National Exchange projects subject to normal business reviews of market conditions and each project's progress to assure acceptable levels of risk and return.

Very truly yours,

Gerald Grinstein

Attachment
Annual Report/10K

1986 Annual Report Form 10-K



BURLINGTON NORTHERN INC.

BURLINGTON NORTHERN INC.

FINANCIAL HIGHLIGHTS

(In Millions, Except Per Share Amounts)

	1986	1985 (1) (2) (Restated)
For the Year:		
Revenues	$ 6,941	$ 8,651
Special Charge (3)	957	—
Operating Income (Loss)	(129)	1,246
Cumulative Effect of Change in Railroad Depreciation Method of Accounting (4)	(336)	—
Net Income (Loss)	(860)	506
Earnings (Loss) per Common Share:		
Earnings (Loss) Before Cumulative Effect of Change in Railroad Depreciation Method of Accounting	(7.53)	7.19
Cumulative Effect of Change in Railroad Depreciation Method of Accounting (4)	(4.54)	—
Earnings (Loss) per Common Share	(12.07)	7.19
Pro Forma Net Income and Earnings per Common Share, Assuming Retroactive Effect of Change in Railroad Depreciation Method of Accounting:		
Net Income (4)	—	557
Earnings per Common Share (4)	—	6.65
At Year End:		
Total Assets	$10,651	$12,256
Long-term Debt	3,394	3,118
Preferred Stock — Redeemable	17	408
Redeemable Preferred Stock of Subsidiary	45	111
Common Stockholders' Equity	3,534	4,512
Book Value per Common Share	47.90	61.32

(1) Previously reported amounts have been restated for successful efforts method of accounting for oil and gas properties. See Note 2 of Notes to Consolidated Financial Statements.

(2) Amounts for 1985 include Southland on the equity method of accounting. See Note 9 of Notes to Consolidated Financial Statements.

(3) The non-cash, pretax Special Charge includes a writedown of the Company's oil and gas properties and a writeoff of surplus railroad assets. See Note 3 of Notes to Consolidated Financial Statements.

(4) The retroactive application of the new method of depreciation is recognized effective as of January 1, 1986. See Note 2 of Notes to Consolidated Financial Statements.

To Our Stockholders

The Company's 1986 operating results include $1.1 billion of non-cash charges to net income which principally reflect changes in accounting methods and reductions in the carrying value of railroad and oil and gas assets. Excluding these effects, pro forma net income was $249 million or $3.46 per share in 1986 compared to $557 million or $6.85 per share in 1985. Free cash flow (funds provided by operations less capital expenditures) increased to $644 million from $455 million in 1985. In recognition of the Company's strong financial position, the Board of Directors increased the annual common dividend by 25% to $2.00 per share.

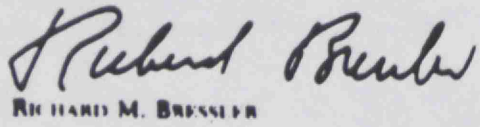
The railroad's position as the low-cost carrier has enabled it to price transportation services aggressively while continuing to provide the reliable and flexible service required by shippers in today's competitive environment. Over the past five years, the railroad has made substantial capital investments in programs designed to reduce costs and increase productivity. These expenditures did much to protect operating margins in a period of flat traffic volumes and declining revenues.

El Paso Natural Gas Company contributed significantly in 1986, providing over one-third of consolidated pro forma operating income. In spite of changing and sometimes conflicting regulatory policies affecting the natural gas transmission industry, EPNG continues to be an efficient transporter of competitively priced natural gas to major markets in California and the Southwest.

The consolidation of Southland Royalty Company, acquired in late 1985 with Meridian Oil was completed during 1986. The Company's energy reserve position now ranks it as one of the largest independent oil and gas operations in the United States. Most of its energy reserves are long lived and strategically located.

Our forest products business was quite successful in 1986 as a result of strong domestic demand and an active export market. Burlington Northern Motor Carriers completed the integration of six independent trucking companies acquired during 1985 and achieved positive operating results. The minerals operation reached active operating status during 1986 and is exploring additional development opportunities. The real estate company continued to increase property values through emphasis on pre-development marketing.

While 1986 was disappointing from an earnings viewpoint, cash flow and the consolidated financial position of the Company continue to be strong. The Company continues to build for the future and in 1986 invested approximately $600 million in capital improvements, all of which was provided through internal cash generation.



RICHARD M. BRESSLER

1986

Form 10-K

Burlington Northern Inc.

SECURITIES AND EXCHANGE COMMISSION

Washington, D.C. 20549

Annual Report Pursuant to Section 13 or 15(d) of
the Securities Exchange Act of 1934

For the fiscal year ended December 31, 1986 Commission file number 1-8159

BURLINGTON NORTHERN INC.

(Exact name of registrant as specified in its charter)

999 Third Avenue, Seattle, Washington 98104-4097

Telephone: (206) 467-3838

Incorporated in the State of Delaware Employer Identification No. 41-1400540

Securities registered pursuant to Section 12(b) of the Act:
Common Stock, without par value;
$10 Par Value Preferred Stock

The above securities are registered on the New York, Midwest and Pacific Stock Exchanges.

11¾% Debentures due 2015; 9¾% Notes due 1996; and 9% Debentures due 2016. These securities are registered on the New York Stock Exchange.

Securities registered pursuant to Section 12(g) of the Act: None

Indicate by check mark whether the registrant (1) has filed all reports required to be filed by Section 13 or 15(d) of the Securities Exchange Act of 1934 during the preceding 12 months (or for such shorter period that the registrant was required to file such reports), and (2) has been subject to such filing requirements for the past 90 days. Yes _X_ No ___

State the aggregate market value of the voting stock held by non-affiliates of the registrant: Common stock aggregate market value as of December 31, 1986, $3,929,014,241.

Indicate the number of shares outstanding of each of the registrant's classes of common stock, as of the latest practicable date. Class: Common Stock, without par value, on December 31, 1986, Shares Outstanding: 73,784,305.

DOCUMENTS INCORPORATED BY REFERENCE

List hereunder the following documents if incorporated by reference and the Part of the Form 10-K (e.g., Part I, Part II, etc.) into which the document is incorporated:

Burlington Northern Inc. definitive proxy statement, to be filed not later than 120 days after the end of the fiscal year covered by this report, is incorporated by reference into Part III.

The Securities and Exchange Commission has not approved or disapproved this Form 10-K, which is included in the Registrant's Annual Report to Stockholders, or passed on the accuracy or adequacy of this report.

BURLINGTON NORTHERN INC.

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PART I

Items One and Two

BUSINESS AND PROPERTIES

Burlington Northern Inc. (the "Company"), through operating subsidiaries, is primarily engaged in transportation and natural resource businesses. The Company's principal business activities are a rail carrier system, a natural gas pipeline, the exploration, development, and production of oil, gas, coal, iron ore, taconite and other minerals, the sale of timber and logs primarily from land owned by the Company, the manufacture and sale of forest products, telecommunications and motor carrier operations. The Company was incorporated in the State of Delaware in 1981 as part of a holding company reorganization.

In the second quarter 1986, the Company recorded a non-cash, pre-tax Special Charge of $857 million and changed the method of accounting for its oil and gas properties from the full cost method to the successful efforts method. Additionally, the Company adopted a new method of depreciation for the majority of its railroad transportation properties. See Notes 2 and 3 of Notes to Consolidated Financial Statements.

SEGMENT INFORMATION

The segment information is set forth in the Financial Statements on pages 23, 24 and 31.

RAILROAD TRANSPORTATION

Burlington Northern Railroad Company ("Railroad") operates the largest railroad system in the United States in terms of total miles of road. The principal cities served include Chicago, Minneapolis-St. Paul, Fargo-Moorhead, Billings, Spokane, Seattle, Portland, St. Louis, Kansas City, Des Moines, Omaha, Lincoln, Cheyenne, Denver, Fort Worth, Dallas, Houston, Galveston, Tulsa, Wichita, Springfield (Missouri), Memphis, Birmingham, Mobile and Pensacola. As of December 31, 1986, the system consisted of 27,706 miles of track, which included 16,490 miles of main lines, 9,049 miles of branch lines and 2,167 miles of secondary main and branch lines.

The contributions of major commodity groups to gross rail freight revenues of Railroad were as follows:

	Year Ended December 31,		
	1986	1985	1984
Agricultural Products			
Grain	10.8%	10.7%	14.2%
Food and kindred products	7.7	7.3	6.3
Other	1.9	1.5	1.7
	20.4	19.5	22.2
Forest Products:			
Lumber and wood products	8.4	7.7	7.0
Pulp, paper and allied products	3.8	3.6	3.2
	12.2	11.3	10.2
Mine Products			
Coal	35.3	39.4	40.5
Stone, clay and glass products	2.4	2.5	2.3
Metallic ores	2.1	2.2	2.3
Non-metallic minerals	1.9	1.9	1.8
	41.7	46.0	46.9
Manufactures and Miscellaneous			
Intermodal	9.9	9.0	7.9
Chemicals and allied products	5.1	4.6	4.1
Primary metal products	2.5	1.9	2.0
Other	8.2	7.7	6.7
	25.7	23.2	20.7
Total	100.0%	100.0%	100.0%

Agricultural Products

Railroad is strategically located to serve the Midwest and Great Plains grain producing regions, and is a prominent rail transporter of grain. Railroad serves all the major terminal, storage, feeding and food processing locations as well as major export markets in the Pacific Northwest, Great Lakes and Gulf regions. Railroad grain tonnage strengthened in 1986 with a 12 percent increase over 1985.

Forest Products

Railroad serves the timber producing regions of the Pacific Northwest, Midwest and the South, hauling significant volumes of lumber, plywood and structural panels, wood chips, wood pulp, paper and paper products. Fluctuations in the level of forest products traffic result from general economic conditions as reflected in new housing and industrial production levels, competition with other modes of transportation, and export demand.

Coal

The transportation of coal is Railroad's largest source of rail freight revenues. The decrease in coal volumes from 1985 was caused by reduced demand and increased competition from other railroads. Coal transportation revenues for 1986 were reduced by $101 million for coal rate litigation reserves. The following table sets forth relevant information about the transportation of coal:

	Year Ended December 31,		
	1986	1985	1984
Coal Transportation Revenues (in millions)	$1,282.6	$1,640.2	$1,861.2
Tons of Coal Originated (in millions)	121.5	129.5	140.7
Coal Revenue Ton Miles (in billions)	95.4	101.8	111.5

During 1986, approximately 98 percent of the coal tonnage originated by Railroad was carried in unit trains. Unit trains haul a single commodity exclusively from origin to destination and return empty to the point of origin on a continuous basis. Coal unit trains typically consist of 107 or more hopper or gondola cars capable of holding 101 tons of coal each and, depending on the difficulty of the grades encountered, from three to six locomotive units.

Approximately 95 percent of the coal unit train traffic originated by Railroad in 1986 originated in the Powder River Basin of Montana and Wyoming and was destined for coal-fired electric generating stations in the Midwest, the Great Plains, Oklahoma and Texas. The balance of the coal traffic originated by Railroad in 1986 came from mines in the Midwest and the South.

Railroad has approximately 95 percent of its coal unit train traffic under contract and is actively pursuing negotiations with several utilities for additional contracts.

In the second half of 1984, Chicago & North Western Transportation Company ("C&NW") commenced coal unit train operations over the Orin-Gillette line in the Powder River Basin and the C&NW's newly built connector line with Union Pacific Railroad Company ("Union Pacific"). On May 15, 1985, the C&NW filed an application with the Interstate Commerce Commission ("ICC") for approval to construct and operate a 10.7 mile line extension in the Powder River Basin in Wyoming to serve three additional coal mines north of Coal Creek Junction. On January 15, 1986, the ICC approved the C&NW line extension application. After the ICC decision, Railroad entered into an agreement to sell a one-half interest in its 10.7 mile line in Wyoming, between Coal Creek Junction and Caballo Junction, to C&NW providing C&NW access to serve those additional mines north of Coal Creek Junction. The sale transaction closed on December 15, 1986.

Intermodal

Railroad continued the use of double-stack cars in 1986 together with other new types of intermodal (trailer and container on flatcar) equipment to reduce costs and improve service. Labor

agreements, which were negotiated with operating crafts to permit use of two-person crews on special shorter haul intermodal trains, were expanded to include additional traffic in 1986.

Operating Factors

Certain significant freight statistics of Railroad were as follows:

	Year Ended December 31,		
	1986	1985	1984
Revenue Ton Miles (in millions)	187,223	184,092	200,580
Revenue Tons Per Carload	70.86	71.32	72.01
Revenue Tons Per Train	2,939	3,018	3,174
Freight Train Miles (in millions)	63.7	61.0	63.2

During 1986, Railroad originated approximately 89 percent of all the rail tonnage it handled.

Road Property

In 1986, approximately 96 percent of the total net ton miles carried by Railroad was handled on its main lines. At December 31, 1986, approximately 18,473 miles of Railroad's tracks consisted of 112-lb. or heavier rail, including approximately 9,647 track miles of 132-lb. or heavier rail. At the same date, 8,583 miles of track were equipped with centralized traffic control. Additions and replacements to road property were as follows:

	Year Ended December 31,		
	1986	1985	1984
Track Miles of Rail Additions and Replacements:			
New	581	668	629
Secondhand	377	406	458
Miles of New Track and Siding Included Above	15	47	84
Track Miles of Continuous Welded Rail Laid in Rail Additions and Replacements Included Above	722	1,028	998
Track Miles of New Centralized Traffic Control Signaling Systems	139	202	135
Track Miles Surfaced or Reballasted	9,631	14,157	13,567
Ties Inserted (in thousands)	2,223	3,858	4,559

Equipment

Railroad owned or leased the following units of railroad rolling stock at December 31, 1986:

	Number of Units		
	Owned	Leased	Total
Locomotives:			
Freight	715	1,285	2,000
Passenger	--	25	25
Multi-purpose	283	—	283
Switching	219	—	219
Total Locomotives	1,217	1,310	2,527
Auxiliary Units	3	—	3
Total Locomotives and Auxiliary Units	1,220	1,310	2,530
Freight Cars:			
Box-general purpose	2,964	3,346	6,310
Box-specially equipped	4,970	364	5,334
Gondola	6,224	376	6,600
Hopper-open top	8,579	1,856	10,435
Hopper-covered	18,634	708	19,342
Refrigerator	3,333	1,166	4,499
Flat	4,204	18	4,222
Caboose	857	—	857
Other	1,534	6	1,540
Total Freight Cars	51,319	7,840	59,159
Commuter Passenger Cars	—	141	141

The average age (in years) of locomotives and freight cars was 13.9 and 15.8, respectively, at December 31, 1986, compared to 13.2 and 15.8, respectively, at December 31, 1985.

The average percentage of Railroad's locomotives and freight cars awaiting repairs during 1986 was 5.2 and 3.5, respectively, compared to 3.9 and 2.6, respectively, in 1985.

OIL AND GAS

The Company's oil and gas segment includes oil and gas exploration and production activities, intrastate natural gas pipeline systems and the production and marketing of natural gas liquids ("NGL").

Meridian Oil Inc. ("Meridian") provides exploration, development, production and management services to all of the Company's oil and gas production properties. Meridian has oil and gas activity in substantially all of the major producing areas of the continental United States. Virtually all oil and gas production is from property located in the United States. Data presented for Meridian herein reflects all of the Company's oil and gas production activities, intrastate natural gas pipeline systems and the production and marketing of NGL's, excluding Southland Royalty Company ("Southland") in 1985 and 1984.

Meridian's capital expenditures were as follows:

	Year Ended December 31,		
	1986	1985	1984
		(In Thousands)	
Oil and Gas Activities	$ 96,031	$302,828	$214,714
Intrastate Pipeline	12,594	20,697	10,699
Administrative	7,438	11,321	6,698
Total	$116,063	$334,846	$232,111

Capital expenditures for Oil and Gas activities include exploration costs expensed under the successful efforts method of accounting and capitalized interest. The decrease in 1986 expenditures is a result of lower oil and gas sales prices. Drilling activity was greatest in the San Juan Basin, the Williston Basin, the Permian Basin, the Gulf Coast and the shallower portion of the Anadarko Basin. The 1986 program resulted in net reserve additions of 6.2 million barrels ("MMBbls") of oil and 81 billion cubic feet ("BCF") of gas and also converted net reserves of 6.8 MMBbls and 190 BCF from proved undeveloped to proved developed.

Meridian's net oil and gas production for 1986 was 11.1 MMBbls and 145 BCF, respectively, as compared to 5.0 MMBbls and 107 BCF, respectively, in 1985. The increase in 1986 oil and gas production is principally due to the acquisition of Southland in December 1985.

Producing Wells, Developed and Undeveloped Acreage

At December 31, 1986, interests in productive wells and developed and undeveloped acreage were as follows:

Productive Wells				Developed Acres		Undeveloped Acres	
Gas		Oil					
Gross	Net	Gross	Net	Gross	Net	Gross	Net
10,646	4,812	11,170	1,950	4,290,000	2,168,000	5,151,000	2,731,000

Drilling Activity

The following table sets forth Meridian's net productive and dry wells completed:

	Year Ended December 31,		
	1986	1985	1984
Productive Wells:			
Exploratory	13.3	19.4	30.6
Development	86.8	225.1	45.7
	100.1	244.5	76.3
Dry Wells:			
Exploratory	19.1	37.4	44.6
Development	12.2	23.2	16.3
	31.3	60.6	60.9
Total net wells	131.4	305.1	137.2

As of December 31, 1986, 42 gross wells, representing approximately 18.8 net wells, were being drilled.

Oil and Gas Production and Sales

Refer to Part II, Item Eight – Financial Statements and Supplementary Data for oil and gas production. Approximately 54 percent of the 1986 gas production was sold to El Paso Natural Gas Company ("EPNG") and 11 percent was transported to direct sale customers through EPNG's pipeline facilities. Meridian expects to continue to sell or transport a substantial portion of its gas production to or through EPNG's pipeline but is also seeking new customers in order to broaden its marketing base.

Meridian's average oil and gas sales prices, production costs (lifting costs) and depreciation, depletion and amortization ("DD&A") rates were as follows:

	Year Ended December 31,		
	1986	1985	1984
Average Sales Prices:			
Oil per barrel	$14.08	$25.11	$28.63
Gas per thousand cubic feet ("MCF")	1.74	2.51	2.83
Average Production Costs per Equivalent MCF*	0.57	0.57	0.64
DD&A Rates per Equivalent MCF	0.75	0.75	0.60

* "Equivalent MCF" refers to combined oil and gas production with oil converted to gas on the basis of 6 MCF per barrel of oil.

Proved Reserves

Refer to Part II, Item Eight — Financial Statements and Supplementary Data for volumetric data pertaining to proved oil and gas reserves. For reserves reported to other agencies, refer to Item One — Natural Gas Operations.

Intrastate Pipelines and NGL Marketing

Meridian operates two intrastate natural gas pipeline systems in west Texas totalling approximately 700 miles and is engaged in the production and marketing of NGL.

Meridian sells natural gas from its intrastate systems in Texas to industrial customers, electric utilities, and other intrastate pipeline companies. NGL's are sold to a variety of wholesale and industrial customers. Approximately 38 percent of Meridian's 1986 NGL sales were to El Paso Products Company, a nonaffiliated entity, pursuant to a contract expiring in 1993.

Meridian's natural gas throughput and NGL sales and production were as follows:

	Year Ended December 31,		
	1986	1985	1984
Natural Gas Throughput (BCF):			
Sales	57	69	78
Transportation	12	18	—
Total	69	87	78
NGL (MMB'ls):			
Sales	17.1	21.0	19.2
Production:			
Meridian owned Plants	4.8	5.5	4.4
EPNG owned Plants	10.0	13.5	14.3
Total	14.8	19.0	18.7

NGL sales volumes have been greater than production volumes due to trading activities conducted by Meridian.

Meridian purchases the majority of its natural gas supplies from nonaffiliated independent producers. Meridian's weighted average cost of purchased gas was $1.96 per MCF in 1986. As of December 31, 1986, contract reserves dedicated to Meridian's intrastate pipeline systems were 341 BCF.

Meridian's intrastate pipeline activities are regulated by the Texas Railroad Commission.

NATURAL GAS OPERATIONS

EPNG owns and operates a 22,000 mile long interstate natural gas pipeline and gathering system in the southwestern and western United States.

Natural Gas Throughput

EPNG Throughput
(Volumes in BCF)

	Sales		Transportation		Total	
	1986	1985	1986	1985	1986	1985
Southern California Gas Company	235	442	258	145	493	587
Pacific Gas and Electric Company	96	279	124	21	220	300
Total California	331	721	382	166	713	887
East-of-California	70	157	96	24	166	181
Total	401	878	478	190	879	1,068

EPNG's total throughput of natural gas in 1986 was 18 percent less than throughput in 1985. Sales volumes declined to less than half of the 1985 total, but the loss was partially offset by transportation volumes, which more than doubled.

The principal reasons for the decline in throughput were lower gas usage for electric generation because more nuclear and hydroelectric power was available, warmer winter weather in EPNG's market area, and some switching from gas to lower-priced fuel oil by industry and electric utilities.

Sales volumes dropped to 401 BCF in 1986, compared to 878 BCF in 1985, primarily because EPNG's customers bought more spot gas. Transportation volumes increased to 478 BCF in 1986, compared to 190 BCF in 1985 as a result of greater activity in the spot market fostered by the gas surplus and severe competition with fuel oil, and federal and state regulatory changes which encourage pipeline and distribution companies to offer transportation service.

Through its deliveries to Southern California Gas Company and Pacific Gas and Electric Company, EPNG supplied approximately 50 percent of all natural gas consumed in California in 1986. Approximately 80 percent of EPNG's total deliveries were to California.

Natural Gas Supplies

EPNG purchases the majority of its natural gas supplies from nonaffiliated independent producers and other pipelines pursuant to gas purchase contracts with producers in the Permian Basin of west Texas and southeastern New Mexico, the Anadarko Basin of western Oklahoma and the San Juan Basin of northwestern New Mexico. In 1986, EPNG obtained 15.4 percent of its natural gas supplies from Meridian. EPNG's total weighted average cost of purchased gas was $2.15 per MCF in 1986.

Gas supplies committed to EPNG continue to exceed market demands for gas by EPNG's sales customers who are no longer obligated to purchase gas from EPNG as a result of federal and state regulatory orders.

During the past several years, EPNG has successfully renegotiated many of its gas purchase agreements to obtain market sensitive pricing provisions and waiver of producer take-or-pay claims. More recently, EPNG has offered producers the opportunity to participate in its spot market release program which affords the producers increased marketing flexibility while relieving EPNG of a portion of its take-or-pay obligation. EPNG has received unresolved take-or-pay claims for periods through 1986 of approximately $300 million and, based on current sales levels, will be exposed to large additional take-or-pay claims for 1986 and later years. EPNG has initiated discussions with its producers seeking to settle 1986 and prior years take-or-pay claims. If EPNG is ultimately required to make substantial take-or-pay payments to producer suppliers, it would be necessary to fund the cash requirements pending make-up of the gas, repayment by suppliers, collection from customers or such other provisions for recoupment of such costs as the Federal Energy Regulatory Commission ("FERC") might order. To the extent that EPNG is required to pay amounts in connection with take-or-pay claims, EPNG believes that it would be permitted to reflect such costs in its rates. However, market conditions could affect EPNG's ability to recover such costs. In this regard, EPNG filed a petition with the FERC on October 31, 1986, for authority to directly bill its interstate pipeline system customers for costs which it prudently incurs to settle past and future take-or-pay claims of its producer suppliers. On November 28, 1986, the FERC set EPNG's proposal for hearing.

During 1986, EPNG purchased gas for resale to its customers from its suppliers on a "least cost" basis to fulfill its duties under the Natural Gas Act of 1938 ("NGA") to offer gas to the market at the lowest reasonable costs consistent with market conditions and with maintaining an adequate supply. Various producer suppliers have brought actions against EPNG in federal and state courts in New Mexico, Texas and Oklahoma alleging contract breach and seeking monetary damages and orders enjoining EPNG to purchase gas from them, regardless of price or market demand. EPNG believes that it has complied with its contract obligations as affected by governmental orders and is vigorously defending its actions. Under existing FERC rules, EPNG has the right to recover, in rates, additional gas costs which it might be forced to incur from any adverse decisions in these cases.

System Gas Reserves and Availability

The following table sets forth as of December 31, 1986, the total reserves dedicated to EPNG's interstate pipeline system:

Summary of Gas Reserves
(Volumes in BCF)

Permian system	3,949
Anadarko system	2,246
San Juan system	8,630
Other reserves	187
Total	15,012*

* EPNG reserves include 3,080 BCF attributable to Mexican and 272 BCF of working interest reserves.

Miller and Lents, Ltd., independent oil and gas consultants, has made a study, as of December 31, 1986, of availability of gas for such systems. The summary report of such study, dated January 7, 1987, states, in part, the following:

"The reserve life index, based on proved developed and undeveloped gas reserves of 15,046 billion cubic feet ("BCF") as of December 31, 1986 is equivalent to approximately 21.6 years' supply based on estimated sales and pipeline use of 696 BCF during the twelve months' period ending December 31, 1986.

10)

"The following table sets forth, for the year 1986, the average daily volume of gas received by EPNG's interstate pipeline system and, for the period 1987-1991, the estimated average daily availability of gas from proved developed gas reserves dedicated to such system on December 31, 1986. With respect to the 1987-1991 period, 'availability' refers to that quantity of gas (before giving effect to EPNG's fuel, shrinkage, and losses) which can be produced from current proved developed reserves under existing contracts and agreements, using presently installed equipment under existing economic and operating conditions.

Availability of Gas
For the Period 1987 through 1991
EPNG INTERSTATE PIPELINE SYSTEM
(Volumes in MMCF)

	Annual Average Day				
Actual Production	Estimated				
1986	1987	1988	1989	1990	1991
1,906	3,201	2,905	2,723	2,495	2,206

"The foregoing estimate of availability of gas for 1987-1991 does not give effect to the development of the presently proved undeveloped reserves dedicated to EPNG's interstate pipeline system nor to the discovery or acquisition of additional reserves after December 31, 1986.

"The deliveries of gas by EPNG's interstate system are subject to various factors beyond its control, including market conditions, regulations and competition for supplies, which may affect EPNG's delivery requirements."

Regulation

EPNG's interstate gas pipeline activities are regulated by the FERC pursuant to the provisions of the NGA and the Natural Gas Policy Act of 1978 ("NGPA").

Since October 1, 1983, EPNG has priced gas produced from certain of its cost-of-service oil and gas properties ("Mid-Louisiana Properties") under the NGPA in accordance with the United States Supreme Court's *Mid-Louisiana* decision and certain FERC orders which are final and no longer subject to judicial review.

The FERC has not yet taken action in response to the June 13, 1986 reversal and remand by the United States Court of Appeals for the District of Columbia Circuit in *Phillips Petroleum Company, et al., v. Federal Energy Regulatory Commission* of certain general orders which it issued after the *Mid-Louisiana* decision regarding the pricing of certain pipeline production. It remains unclear what action the FERC will take and whether it will have any impact upon the pricing of gas from certain Mid-Louisiana Properties.

Rate Matters

EPNG's current base tariff rates for interstate sales and transportation service were established pursuant to a general rate filing settlement agreement approved by the FERC which became effective July 1, 1985. The settlement permits EPNG to recover its revenue requirements through either natural gas sales or transportation service.

EPNG's FERC Gas Tariff includes a purchase gas adjustment clause which permits EPNG to adjust its sales rates at least twice each year in order to reflect increases or decreases in the cost of natural gas purchased by EPNG. Until these costs are recovered in rates, such amounts are included in

Recoverable Excess Gas Costs in the accompanying Consolidated Financial Statements. As a result of EPNG's continuing efforts to be competitive in its markets, the net effect of EPNG's sales rates for the two regular April 1, 1986 and October 1, 1986 adjustments and the July 1, 1986 out-of-period adjustment was a decrease of $0.40 per dekatherm (the energy heat equivalent of one million Btu's).

Transportation

On October 9, 1985, the FERC issued Order No. 436 fundamentally altering its regulations governing the pipeline transportation of gas in interstate commerce. Any pipeline which initiates the transportation of gas after October 9, 1985, must use its available capacity to provide, without discrimination, the same transportation service for all shippers on a first come, first served basis. When the pipeline first commences or continues transportation arrangements under the new regulations, its existing firm sales customers have the option to reduce their firm sales entitlements with the pipeline and the option to convert from firm sales to firm transportation service on the pipeline system. Opening a pipeline system to nondiscriminatory, self implementing transportation service, affords the pipeline the opportunity to undertake transportation services without specific prior authorization by the FERC. Otherwise, a pipeline must seek appropriate FERC approvals before it may provide transportation for any party, inclusive of self implementing transactions.

On January 17, 1986, EPNG initiated new transportation service on its system under FERC's Order No. 436. By so doing, EPNG has entered into new self-implementing transportation arrangements on behalf of any local distribution company or intrastate pipeline on a first come, first served basis. As measured against the present purchase rights of its existing customers, EPNG does not have, at this time, any excess capacity on its system available for new firm transportation service during peak demand periods. On January 12, 1987, the FERC issued its final order approving the terms and conditions applicable to EPNG's open access transportation service under FERC Order No. 436. EPNG has until February 11, 1987 to accept this final order.

Filings of Reserve Estimates with Other Agencies

On March 31, 1986, EPNG filed with the FERC its annual Form No. 15 Report which included an estimate of total remaining recoverable gas reserves dedicated to its interstate system as of December 31, 1985. EPNG also filed with the FERC, on April 30, 1986, its Form No. 2 Report reflecting an estimate of the total remaining recoverable interstate, intrastate and off-system gas reserves of EPNG as of December 31, 1985. In addition, estimates are from time-to-time furnished to governmental agencies, including the FERC, in connection with matters pending before such agencies. In some cases, the basis for reporting reserves to these agencies is not comparable to that furnished herein because of the nature of the reports required. The major differences are attributable to the time the estimates are made, the companies for which the estimates are made and the requirements to report on a gross, net or total operator basis. EPNG does not file reports of the total proved interstate, intrastate or off-system oil or gas reserves with any other federal agency.

FOREST PRODUCTS

Plum Creek Timber Company, Inc. (Plum Creek) manages approximately 1.5 million acres of timberland in Washington, Oregon, Idaho and Montana. Timber sold from these lands in 1986, 1985 and 1984 was 669, 603 and 553 million board feet, respectively. The increase in harvest during the past three years reflects Plum Creek's plan to harvest overmature timber and reforest its land with superior growing stock.

Plum Creek has softwood manufacturing facilities in Montana and Washington. Annual rated capacity for 1986 was 380 million board feet of lumber, 235 million square feet of plywood (⅜" basis) and 79 million square feet of fiberboard (½" basis). Sales volume for 1986 was 338 million board feet of

lumber, 242 million square feet of plywood and 76 million square feet of fiberboard. In 1986, approximately 65 percent of Plum Creek's mill log requirements were obtained from Company lands.

OTHER ACTIVITIES

Meridian Minerals Company manages coal reserves estimated at 14,539, 14,552 and 14,566 million tons for the years 1986, 1985 and 1984, respectively. The average royalties derived from the development of such reserves for such years were $0.24, $0.22 and $0.22 per ton, respectively.

Burlington Northern Motor Carriers Inc. ("BNMC") completed its initial acquisition program by early 1986 with the purchase of six companies. BNMC has maintained the local identity and market presence of five of these carriers. The sixth has been merged into an existing carrier. These companies provide primarily dry van truckload services in the continental United States.

BNMC controls approximately 1,800 power units (74 percent company-owned) and 3,100 trailers as of December 31, 1986. BNMC generated approximately $180 million in revenues during 1986, the first full year of operation.

Glacier Park Company ("GPC") develops and manages commercial real estate properties, primarily through land development and joint ventures. GPC also manages approximately 1.3 million acres of agricultural land in the western United States.

National Exchange, Inc. ("NEX") is a 90 percent owned subsidiary of the Company acquired on December 31, 1985 for the purpose of developing the Company's telecommunications assets and capabilities. On October 1, 1986, NEX and MCI Communications Corporation ("MCI") reached agreement in principle for the purchase of approximately 2,700 miles of rights of way from the Company, upon which MCI will construct fiber optic capacity between Chicago, Dallas, and Los Angeles. In addition, NEX will install 2,850 miles of digital microwave capacity in the northwest using the Company's existing microwave facilities, some of which capacity will be utilized by MCI.

ENCUMBRANCES

As of December 31, 1986, approximately 2,398 miles of the former Northern Pacific Railway Company's ("NP") main lines and 1,360 miles of NP's branch lines, together with substantially all of Railroad's natural resource properties ("Resource Properties") were subject to two mortgages under which there were approximately $117.7 million of bonds outstanding at December 31, 1986, including approximately $69.9 million of 4% bonds which mature in 1997 ("Prior Lien Bonds") and $47.8 million of 3% bonds which mature in 2047 ("General Lien Bonds"). Under the terms of these mortgages, Railroad is permitted to sell timber, land and minerals and to lease mineral interests. However, the proceeds from such sales and leases, net of expenses and taxes, must be deposited with the trustees under such mortgages. Except for $500,000 of such proceeds annually, which must be applied to the purchase on the open market of bonds outstanding under such mortgages, such proceeds are available for withdrawal by Railroad upon certification to the mortgage trustees of additions and betterments to Railroad properties subject to those mortgages. There are no other provisions in these mortgages that would allow withdrawal of such proceeds by Railroad except by modification to the mortgages with the consent of the holders of all the outstanding bonds. Railroad has continued to expend money for additions and betterments to such properties, but it cannot give any assurance that future expenditures will be sufficient to permit the withdrawal of all natural resource proceeds. As of December 31, 1986, Railroad had identified approximately $700 million of such additions and betterments that were available for certification to the mortgage trustees, calculated on the basis of property additions through December 31, 1986 using current ICC accounting procedures for ratable depreciation. Railroad will continue to identify and certify additions and betterments as they become available.

On April 21, 1985, Railroad announced that it entered into agreements ("Agreements") with the trustees of these mortgages, pursuant to which (1) Railroad would commence a tender offer ("Offer") for any and all outstanding Prior Lien Bonds and General Lien Bonds, (2) Railroad would deposit United States Government debt obligations ("Government Bond Portfolio") and cash in irrevocable trusts with the trustees, in amounts sufficient to pay the principal at scheduled maturity of and interest when due on all Prior Lien Bonds and General Lien Bonds that remained outstanding after the expiration of the Offer ("Deposit Plan"), and (3) the trustees would execute necessary documentation to accomplish the release of Resource Properties from the liens of the mortgages. In accordance with the Agreements, Railroad commenced the Offer on April 23, 1985, and later purchased the Government Bond Portfolio.

Subsequent to the commencement of the Offer, actions were brought in New York and Delaware state courts and in the United States District Court for the Southern District of New York ("District Court") against Railroad and the trustees seeking to enjoin the consummation of the Agreements between Railroad and each of the trustees. The state court actions are inactive.

On June 21, 1985, the District Court issued an opinion and order granting the plaintiffs' motion for a preliminary injunction. Specifically, the District Court enjoined Railroad and the trustees from: (a) implementing the Agreements; (b) releasing any or all of Resource Properties; and (c) proceeding with the Offer. Following this order, Railroad announced on June 24, 1985, that it was cancelling the Offer. In connection with the cancellation, Railroad sold the Government Bond Portfolio. On July 24, 1985, the District Court modified the preliminary injunction to make clear that the preliminary injunction allowed releases of any or all of Resource Properties in compliance with the mortgages as interpreted in prior practice in customary release transactions.

On February 28, 1986, Railroad filed a motion for summary judgment asking the District Court to dismiss the action because (i) the proposed transactions were lawful, (ii) plaintiffs were not entitled to injunctive relief, and (iii) the issues raised in the plaintiffs' complaint were moot because Railroad had no present intention of engaging in the Deposit Plan. Plaintiffs cross moved for summary judgment to make the preliminary injunction permanent.

On September 3, 1986, the District Court denied both sides' motions for summary judgment. The District Court found that the case was not moot, but it declined to issue a permanent injunction because Railroad had abandoned the proposed transactions. The District Court also said that it "was not fully certain as to the plaintiffs' right to this relief when it issued the preliminary injunction; nothing adduced in relation to this motion diminished our uncertainty." The District Court refused, however, to grant Railroad's motion for summary judgment dismissing the action. On October 6, 1986, Railroad appealed the District Court's decision to the United States Court of Appeals for the 2nd Circuit. The preliminary injunction, which enjoins any releases other than those in compliance with the mortgages as interpreted in prior practice, remains in effect. Railroad intends to continue to develop Resource Properties at a pace and in a manner consistent with restrictions imposed by the mortgages.

A substantial portion of the Company's pipeline systems are constructed and maintained pursuant to rights-of-way, easements, permits, licenses or consents on and across properties owned by others. The compressor stations and related facilities and gasoline extraction plants are located in whole or in part upon land owned by the Company or upon sites held under leases or under permits issued or approved by public authorities.

COMPETITION

The Company faces extensive competition in its railroad operations from deregulated motor carriers, excess capacity in the barge industry and other Class I and short-line railroads stimulated by

the Staggers Rail Act of 1980. The oil and gas, forest products and motor carrier operations also experience intense competition. EPNG encounters competition in the sale of natural gas from other natural gas suppliers and alternative energy sources. The competition is substantially affected by the availability and costs of the competing supply sources. EPNG also encounters competition from other natural gas pipeline companies in the transportation of natural gas. As a major source of natural gas supply in its California market, EPNG is also subject to competitive pressure from Canadian suppliers.

On December 23, 1983, Santa Fe Industries, Inc. and Southern Pacific Co., two railroad holding companies, merged. An application to merge the Atchison, Topeka & Santa Fe Railway Company ("Santa Fe") and Southern Pacific Transportation Company ("Southern Pacific") was denied by the ICC, on October 10, 1986. Santa Fe and Southern Pacific filed a petition to reopen the decision on December 9, 1986, asserting the merger should be reconsidered in light of agreements reached with certain previously opposing railroads. Railroad is evaluating the potential impact of this new merger plan. On November 14, 1986, the Union Pacific Corporation, Union Pacific and Missouri Pacific Railroad Company ("MP") filed an application to control the Missouri-Kansas-Texas Railroad Company. Railroad is currently assessing the competitive impact of this merger. The Union Pacific Corporation has also filed an application to acquire Overnight Transportation, a trucking company. These merger applications are subject to ICC approval.

EMPLOYEES

The Company had approximately 44,200 and 47,500 employees for 1986 and 1985, respectively. The Company's employment has been steadily decreasing due to implementation of job reduction efforts, efficiency improvements and regulatory changes. Approximate disbursements for payroll and employee benefits were $2.1 billion and $2.2 billion in 1986 and 1985, respectively.

Labor organizations represent approximately 71 percent of the Company's employees. Approximately 89 percent of Railroad rail employees are covered by collective bargaining agreements with national railroad labor organizations. On October 31, 1985, Railroad reached an agreement with the United Transportation Union, which represents about 25 percent of Railroad unionized work force. The agreement cannot be changed before June 30, 1988. It provides for a 10.9 percent wage increase over its term (or for cost-of-living adjustments if increases in the Consumer Price Index exceed the programmed wage increases). The agreement also provides for a variety of holddowns and productivity improvements which will partially offset the wage increases. An arbitrated agreement with the Brotherhood of Locomotive Engineers, extending to June 30, 1988, was issued May 19, 1986, covering approximately 10 percent of Railroad unionized employees. Agreements extending to June 30, 1988, were also reached with six of Railroad non-operating unions, including the Brotherhood of Railway and Airline Clerks and the Brotherhood of Maintenance of Way Employees, representing about 50 percent of Railroad unionized employees. These agreements provide for approximately 10.5 percent wage increases over their term (with a significant portion of the increase being paid in lump sums), productivity improvements and holddowns on increases for certain classifications such as intermodal workers. Tentative settlements have also been reached with three other non-operating unions, leaving only two unions in active negotiation.

Item Three -- LEGAL PROCEEDINGS

The Company, Railroad and several other railroads are defendants in a private antitrust action filed by Energy Transportation Systems, Inc. ("ETSI") in the Federal District Court for the Eastern District of Texas at Beaumont ("Court"). The suit seeks unspecified damages in excess of $940 million from the defendants and injunctive relief. The complaint alleges that the railroad defendants violated antitrust laws by conspiring to restrain trade, monopolizing and attempting to monopolize the transportation of Powder River Basin coal to destinations in Kansas, Texas, Louisiana, Arkansas and

Oklahoma. After the suit was filed, Arkansas Power & Light Company ("AP&L") filed a motion to intervene as plaintiff, and ETSI filed a motion to amend its complaint to include Santa Fe as defendant. The Court granted both motions. The Company believes it has been in full compliance with the antitrust laws and will vigorously defend this lawsuit. Trial of this case is tentatively scheduled to begin in September 1987.

The Company, Railroad and several other railroads have been named as defendants in a lawsuit filed by Houston Lighting and Power Company and Utility Fuels, Inc. in the Federal District Court for the Southern District of Texas. The complaint alleges that the railroad defendants conspired to restrain trade, monopolized and attempted to monopolize the transportation of Powder River Basin coal to destinations in Kansas, Texas, Louisiana, Arkansas and Oklahoma by eliminating the ETSI coal slurry pipeline, or substantially reducing its effectiveness as a competitor, in violation of antitrust laws. The complaint also alleges that defendants violated the Racketeer Influenced and Corrupt Organizations Act, and tortiously interfered with a prospective contractual relationship between plaintiffs and ETSI. The suit seeks money damages, punitive damages and injunctive relief. These matters are pending before the court at the present time. The Company believes it has been in full compliance with all applicable laws, and will vigorously defend this lawsuit.

On November 20, 1986, the ICC served a decision requiring Railroad to make approximately $17.9 million plus interest in reparation payments to Omaha Public Power District ("OPPD") in connection with coal rates charged by Railroad for movements of coal from Wyoming to the OPPD power plant near Arbor, Nebraska, between July 1982 and January 1986. Railroad has appealed the ICC's decision to the United States Court of Appeals for the 3rd Circuit on the basis that the ICC lacks jurisdiction over the rates which were found to be unreasonably high and that the reparations decision is not legally sound. In addition, on December 19, 1986, Railroad filed a petition with the ICC requesting that the decision be reconsidered or the record reopened to permit additional cost evidence to be submitted.

Railroad is currently involved in administrative proceedings before the ICC concerning the reasonableness of Railroad's and MP joint and proportional coal rates to AP&L's electric generating facilities near Redfield and Newark, Arkansas. AP&L has alleged that the rates charged by Railroad and MP for the transportation of approximately 25.8 million tons of coal between 1979 and 1984 were unreasonably high and seeks substantial reparations from the railroads together with interest. The ICC decision in the OPPD case could have an adverse impact on the outcome of the AP&L proceeding. Railroad believes that the rates charged to AP&L were reasonable and will challenge any ICC decision ordering rate reparations. On September 18, 1986, Railroad filed a Petition for Leave to File Supplemental Stand-alone Cost Evidence ("Petition") with the ICC in this proceeding. If the ICC grants the Petition, Railroad will submit evidence further demonstrating the reasonableness of the rates at issue.

During 1986, Railroad had two additional coal rate proceedings in litigation before the ICC. The first involved a complaint of City Public Service Board of San Antonio, Texas ("San Antonio") challenging the reasonableness of rates charged for the transportation of coal by Railroad and Southern Pacific between December 1978 and August 1985. The second concerned the reasonableness of Railroad's and C&NW's joint coal rates to the Iowa Public Service Company ("IPS") generating plant near Sergeant Bluff, Iowa between 1979 and 1986. In December 1986, Railroad reached settlement agreements with both utilities which will result in the dismissal of these ICC rate complaint proceedings and related litigation in early 1987.

Railroad does not expect that any additional coal rate cases challenging rates in effect prior to the Staggers Rail Act of 1980 will be brought.

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Various actions have been commenced against the Company, The El Paso Company ("El Paso") and, in certain instances, El Paso's directors, the Company's directors and investment banker, by alleged stockholders of El Paso on their behalf and on behalf of El Paso stockholders who tendered shares in the Company's December 1982 tender offer for the common stock of El Paso and on behalf of El Paso derivatively, arising out of the Company's termination of that offer. Following the announcement of the merger between the Company and El Paso, one of the complaints in these actions was amended to add claims with respect to the merger and the proxy statement used in connection with the merger. These actions variously allege that the defendants violated the federal securities laws and principles of common law and breached their fiduciary duties to the plaintiffs, and seek, among other relief, unspecified amounts of damages. On January 20, 1983, a court order was entered in one action certifying the action as a class action on behalf of all persons, other than the defendants and their affiliates, who are beneficial holders of any of the first 25.1 million shares validly tendered in the December 1982 tender offer prior to termination of that offer. Motions have been filed to dismiss or stay and to consolidate certain of the actions. Four of these actions have been dismissed as to all defendants. In a fifth action the court has dismissed the breach of contract claims asserted against the Company; other claims involving alleged breaches of fiduciary duty by El Paso remain pending. The Company believes that all of these actions are without merit and intends to vigorously defend against them.

In late April 1985, Southland Royalty Company ("Southland") was notified by HT Gathering Company ("HT"), the purchaser of certain of the gas produced from Southland's Waddell Ranch properties in Crane County, Texas, that HT would immediately cease purchasing such gas. The reason cited by HT for such action was its purported concern whether such gas had been dedicated to the interstate market by the previous lease holder, Gulf Oil Corporation, prior to reversion to Southland and others of the Waddell Ranch properties in 1975. Southland has sold such gas to HT under an intrastate contract since reversion. Southland, joined by other producing interest owners, protested HT's action and filed a lawsuit in Crane County, Texas, seeking to enforce their gas contracts with HT. That case was subsequently removed to the United States District Court for the Western District of Texas. The federal judge subsequently referred the matter to the FERC for a determination of the dedication issue. The FERC has issued an order referring the matter to an administrative law judge for hearing; such hearing is presently scheduled to commence in May 1987. The Company will vigorously assert its position in this matter and pursue all available remedies to enforce the contract with HT.

Item Four

SUBMISSION OF MATTERS TO A VOTE OF SECURITY HOLDERS

During the fourth quarter of 1986, no matters were submitted to a vote of security holders.

A resolution seeking a report on safety considerations in Railroad transportation of nuclear materials was submitted for inclusion in the Company's Proxy Statement for the 1987 Annual Meeting and was subsequently withdrawn. The Company has prepared a report addressing the subject. To secure a copy of the report, write to Leslie S. Gibbs, Corporate Secretary, Burlington Northern Inc., 999 Third Avenue, Seattle, Washington 98104-4097.

EXECUTIVE OFFICERS OF THE REGISTRANT

Richard M. Bressler, 56
Chairman of the Board,
President and Chief Executive
Officer and Director
Since January, 1982 to Present

Mr. Bressler is a Director of General Mills Inc., Baker International, and Rockwell International Corporation.

Walter A. Drexel, 56
Vice Chairman of the Board and Director
Since December, 1985 to Present

Senior Vice President, Strategic Planning, May, 1981 to April, 1982, Director, July, 1982 to present, Burlington Northern Inc.; President and Chief Operating Officer, April, 1982 to February, 1983, Chairman of the Board, President and Chief Executive Officer, February, 1983 to December, 1985, Burlington Northern Railroad Company. Mr. Drexel is a Director of the M Bank, Fort Worth.

Gerald Grinstein, 54
Director
Since October, 1985 to Present

Elected, Vice Chairman of the Board, January 29, 1987, Burlington Northern Inc., effective April 1, 1987. Law partner, December 1978 to April, 1983, Preston Thorgrimson, Ellis & Holman. Chairman of the Board, April, 1983 to January, 1984, President and Chief Operating Officer, January, 1984 to January, 1985, Chief Executive Officer, January, 1983 to February, 1986, Chairman and Chief Executive Officer, February, 1986 to present, Western Air Lines, Inc. Mr. Grinstein is a Director of General Telephone Company of California and Delta Airlines, Inc.

Thomas H. O'Leary, 52
Vice Chairman of the Board and Director
Since August, 1982 to Present

President, May, 1974 to August, 1982, Missouri Pacific Corporation. Mr. O'Leary is a Director of INTERCO, INC., The Kroger Company and Rainier Bancorporation.

Travis H. Petty, 58
Vice Chairman of the Board and Director
Since December, 1983 to Present

For over five years, Chairman of the Board and President, of The El Paso Company. Mr. Petty is a Director of Texas Commerce Bancshares, Inc., and Texas Commerce Bank—El Paso.

Christopher T. Bayley, 48
Senior Vice President, Corporate Affairs
Since December, 1986 to Present

Partner, July, 1980 to January, 1983, Perkins Coie; Senior Vice President, Law, January, 1983 to December, 1983, Senior Vice President, Law and Corporate Affairs, December, 1983 to December, 1986, Burlington Northern Inc.; President and Chief Executive Officer, Glacier Park Company, December, 1985 to date.

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Allan R. Boyce, 43
Senior Vice President, Human Resources
Since October, 1984 to Present

Vice President, Public Affairs, November, 1981 to October, 1984, Burlington Northern Inc.

Luigi Dell'Osso, Jr., 47
Senior Vice President, Finance and Planning
Since April, 1984 to Present

Director of Corporate Planning and Economics, October, 1979 to November, 1981, Vice President, November, 1981 to August, 1983, Senior Vice President, August, 1983 to April, 1984, The El Paso Company.

James W. Decker, 44
Vice President and General Counsel
Since December, 1986 to Present

Assistant General Counsel, May, 1981 to August, 1983, Assistant Vice President, Law, September, 1983 to December, 1984, Vice President, Law, January, 1985 to December, 1986, Burlington Northern Inc.

George E. Hewison, 42
Vice President and Treasurer
Since June, 1985 to Present

Assistant Controller, June, 1979 to October 1982, Controller, October, 1982 to July, 1983, Southwest Forest Industries, Inc.; Vice President, Finance, July, 1983 to December, 1984, Vice President, Finance and Planning, December, 1984 to June, 1985, Plum Creek Timber Company, Inc.

Leslie S. Gibbs, 38
Corporate Secretary
Since April, 1986 to Present

Executive Secretary to President and Chief Executive Officer, May, 1981 to May, 1983, Executive Assistant to President and Chief Executive Officer, May, 1983 to April, 1985, Plum Creek Timber Company, Inc.; Assistant Corporate Secretary, May, 1985 to April, 1986, Burlington Northern Inc.

EXECUTIVE OFFICERS OF PRINCIPAL SUBSIDIARIES

Darius W. Gaskins, Jr., 47
President and Chief Executive Officer
Burlington Northern Railroad Company
Since December, 1985 to Present

Senior Vice President prior to August, 1982, Natomas North American Corporation; Senior Vice President, Marketing and Sales, August, 1982 to July, 1985, President and Chief Operating Officer, July, 1985 to December, 1985, Burlington Northern Railroad Company.

Richard S. Morris, 54
President and Chief Executive Officer
El Paso Natural Gas Company
Since December, 1985 to Present

Executive Vice President, April, 1981 to August, 1983, The El Paso Company; President, August, 1983 to December, 1985, El Paso Natural Gas Company.

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Billy B. Ross, 46
President and Chief Executive Officer
Meridian Oil Inc.
Since March, 1986 to Present

Vice President and Controller prior to November, 1982, Senior Vice President and Controller, November, 1982 to April, 1983, The El Paso Company. Senior Vice President and Treasurer, April, 1983 to January, 1985, El Paso Natural Gas Company. President and Chief Executive Officer, January, 1985 to present, El Paso Hydrocarbons Company

David D. Leland, 51
President and Chief Executive Officer
Plum Creek Timber Company, Inc.
Since April, 1983 to Present

Executive Vice President, Building Products Group prior to April, 1983, Southwest Forest Industries, Inc.

Michael L. Lawrence, 42
President and Chief Executive Officer
Burlington Northern Motor Carriers Inc.
Since May, 1984 to Present

President, Independent Contractor Group, November, 1981 to May, 1984, Schneider National Inc.

Christopher T. Bayley, 48
President and Chief Executive Officer
Glacier Park Company

Listed as Executive Officer of Registrant.

Gordon W. Thompson, 45
President and Chief Executive Officer
Meridian Minerals Company
Since December, 1983 to Present

Vice President, Operations, September, 1981 to August, 1982, Senior Vice President, New Projects, August, 1982 to October, 1983, Anaconda Minerals Company, Senior Vice President, Operations, October, 1983 to December, 1983, Meridian Minerals Company.

Clay T. Whitehead, 48
President and Chief Executive Officer
National Exchange, Inc.
Since April, 1983 to Present

President, January, 1979 to March, 1983, Hughes Communications, Inc., a subsidiary of Hughes Aircraft Company.

PART II

Item Five

MARKET FOR REGISTRANT'S COMMON EQUITY AND RELATED STOCKHOLDER MATTERS

The Company's common stock is traded on the New York, Midwest and Pacific Stock Exchanges. At December 31, 1986, the number of common stockholders was 40,118.

Information on quarterly dividends and common stock prices is shown on page 45 and incorporated herein by reference.

Item Six

SELECTED FINANCIAL DATA

	Year Ended December 31,				
	1986	1985 (1) (2) (Restated)	1984 (1) (Restated)	1983 (1) (3) (Restated)	1982 (1) (Restated)
	(In Millions, Except per Share Amounts)				
For the Year:					
Revenues	$ 6,941	$ 8,651	$ 9,156	$ 4,508	$4,192
Special Charge (4)	957	—	—	—	—
Operating Income (Loss)	(129)	1,246	1,374	732	471
Income (Loss) from Continuing Operations	(524)	596	569	400	279
Discontinued Operations	—	—	—	—	106
Cumulative Effect of Accounting Change (5)	(336)	—	—	—	—
Net Income (Loss)	(860)	596	569	400	385
Earnings (Loss) for Common Stock	(893)	531	492	389	376
Earnings (Loss) per Common Share					
Continuing Operations	(7.53)	7.19	6.63	5.22	3.63
Discontinued Operations	—	—	—	—	1.42
Cumulative Effect of Accounting Change (5)	(4.54)	—	—	—	—
Earnings (Loss) per Common Share	(12.07)	7.19	6.63	5.22	5.05
Dividends Declared per Common Share	1.30	1.45	1.10	1.115	0.76
At Year-End:					
Total Assets	$10,651	$12,256	$11,287	$10,838	$7,025
Long-term Debt	3,394	3,118	2,454	2,930	1,330
Preferred Stock — Redeemable	17	408	441	443	105
Redeemable Preferred Stock of Subsidiary	45	111	256	266	—
Common Stockholders' Equity	3,534	4,912	4,100	3,739	3,423

(1) Previously reported amounts have been restated for successful efforts method of accounting for oil and gas properties. See Note 2 of Notes to Consolidated Financial Statements.

(2) Amounts for 1985 include Southland on the equity method of accounting. See Note 9 of Notes to Consolidated Financial Statements.

(3) Amounts for 1983 include The El Paso Company's ("El Paso") results of operations on the equity method of accounting. The December 31, 1983 consolidated balance sheet includes El Paso assets acquired and obligations assumed.

(4) The non-cash, pretax Special Charge includes a writedown of the Company's oil and gas properties and a writeoff of surplus railroad assets. See Note 3 of Notes to Consolidated Financial Statements.

(5) The retroactive application of the new method of depreciation is recognized effective as of January 1, 1986. The change in method had the effect of decreasing Net Income on a pro forma basis for the years 1985 through 1982 by $40 million, $0.54 per share; $44 million, $0.59 per share; $30 million, $0.40 per share, and $12 million $0.16 per share, respectively. See Note 2 of Notes to Consolidated Financial Statements.

Operating Loss for 1986 was $129 million which includes a pre-tax Special Charge of $957 million compared to pro forma Operating Income (adjusted for the impact of the change in Railroad depreciation method of $77 million and $85 million in 1985 and 1984, respectively) of $1,160 billion and $1,289 billion in 1985 and 1984, respectively.

Railroad revenues decreased 7 percent from 1985, which decreased 9 percent from 1984. The changes in revenues were affected by volume changes, freight mix, price adjustments to meet competition and coal rate litigation reserves totalling $101 million. Railroad volume, as measured in revenue ton miles, increased 2 percent from 1985 which decreased 8 percent from 1984. Grain traffic volume and revenues increased 9 percent and 1 percent, respectively, from 1985, which decreased 25 percent and 23 percent, respectively, from 1984. Coal and taconite, Railroad's major commodity group, had a decrease in volume and revenues of 7 percent and 13 percent, respectively, from 1985, which decreased 9 percent and 12 percent, respectively, from 1984. Natural Gas Operations revenues were $2.1 billion, $3.7 billion and $4.0 billion in 1986, 1985 and 1984, respectively. Natural Gas Operations revenues decreased due to lower sale volumes and lower average sale prices. This decrease was partially offset by an increase in transportation revenues. Oil and Gas revenues were $741 million, $986 million and $1,064 million in 1986, 1985 and 1984, respectively. The decline results from lower sale prices, partially offset by increased production volumes due in part to the acquisition of Southland.

Railroad costs and expenses increased 1 percent from 1985, which decreased 7 percent from 1984. The changes in costs and expenses were affected by traffic volumes, depreciation, diesel fuel and labor costs. Depreciation, diesel fuel and labor costs were $312 million, $261 million and $1.8 billion, respectively, in 1986 compared to $234 million, $401 million and $1.8 billion, respectively, in 1985, and $226 million, $468 million and $1.9 billion, respectively, in 1984. The 1986 Railroad operating ratio was 97.3 percent, compared to 80.7 percent in 1985 and 78.7 percent in 1984. The Special Charge and change in Railroad depreciation method of accounting resulted in an increase of 11.5 to the 1986 operating ratio. Natural Gas Operations costs and expenses were $1.9 billion in 1986, compared with $3.4 billion in 1985 and $3.7 billion in 1984. The decrease in costs and expenses resulted from reduced purchased gas volumes and costs, and lower operation and maintenance expenses including production related costs. Oil and Gas costs and expenses totaled $722 million in 1986, compared with $889 million and $912 million in 1985 and 1984, respectively.

Interest Expense increased to $389 million, compared to $312 million in 1985 and $310 million in 1984. The increase is substantially due to debt incurred in connection with the acquisition of Southland and the redemption of preferred stock.

Other Income (Expense)—Net was $63 million, $106 million and $(18) million in 1986, 1985 and 1984, respectively. The decrease in 1986 is primarily due to a reserve for a sale of properties, lower interest and dividend income, and interest charges on the San Antonio and OPPD rate cases, partially offset by higher equity income and the sale of one-half of Railroad's interest in the 10.7 mile line extension in Wyoming, between Coal Creek Junction and Caballo Junction. Both 1986 and 1985 include collection of previously reserved notes. The increase in 1985 is primarily due to higher interest income, partial collection of a note (previously reserved), and gain on sale of Burlington Northern Airmotive Inc. Additionally, certain 1984 nonrecurring items, including reserves for litigation and the Timber Industry Relief Bill, and reversal of interest on estimated tax liabilities, affected the increase in 1985. Interest and dividend income was $37 million, $40 million and $18 million in 1986, 1985 and 1984, respectively.

As a result of the Tax Reform Act of 1986, the provision for income taxes for the fourth quarter 1986 was adjusted to reflect the loss of approximately $32 million in investment tax credits which had been reflected in the tax provision for the first three quarters of 1986. (See Note 5 of Notes to

Consolidated Financial Statements.) The Tax Reform Act of 1986 will not have a significant effect on the Company's future financial condition or results of operations.

Preferred dividend requirements decreased to $33 million, compared to $66 million and $77 million in 1985 and 1984, respectively. The reduction is due to preferred stock redemptions and the decline in the Adjustable Rate Series preferred stock dividend requirement.

OTHER MATTERS

See "Legal Proceedings", pages 13, 14 and 15, and "Natural Gas Operations", pages 7, 8, 9 and 10 for information concerning litigation and other matters.

EFFECT OF INFLATION

The Company generally has experienced increased costs in recent years due to the effect of inflation on the cost of labor, material and supplies, and plant and equipment. A portion of the increased labor and material and supplies costs directly affects income through increased maintenance and operating costs. The cumulative impact of inflation over a number of years has resulted in higher depreciation and depletion expenses and increased costs for current replacement of productive facilities. However, operating efficiencies have partially offset this impact, as have price increases, although the latter have generally not been adequate to cover increased costs due to inflation. Competition and other market factors limit the Company's ability to price services or products based upon inflation's effect on costs.

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Item Eight

FINANCIAL STATEMENTS AND SUPPLEMENTARY DATA

CONSOLIDATED SEGMENT INFORMATION

	Year Ended December 31,		
	1986	1985(1) (Restated)	1984(1) (Restated)
	(In Thousands)		
Revenues:			
Railroad	$3,800,560	$4,098,464	$4,490,221
Natural Gas Operations(2)(3)	2,149,243	3,676,491	3,996,991
Oil and Gas(3)	740,566	985,921	1,064,054
Forest Products	285,780	258,428	273,885
Other and Eliminations(4)	(34,736)	(368,377)	(666,014)
Total	$6,941,413	$8,650,927	$9,156,337
Costs and Expenses:			
Railroad	$3,295,276	$3,276,318	$3,510,534
Natural Gas Operations(3)	1,854,142	3,360,321	3,743,074
Oil and Gas(3)	721,793	888,986	911,859
Forest Products	232,439	212,401	231,475
Other and Eliminations(4)	9,374	(333,123)	(615,075)
Total	$6,113,024	$7,404,905	$7,781,967
Special Charge(5):			
Railroad	$ 352,498	$ —	$ —
Oil and Gas	604,594	—	—
Total	$ 957,092	$ —	$ —
Operating Income (Loss):			
Railroad	$ 152,786	$ 822,146	$ 979,687
Natural Gas Operations(3)	295,101	316,168	253,917
Oil and Gas(3)	(585,821)	96,935	152,195
Forest Products	53,341	46,027	42,410
Other and Eliminations	(44,110)	(35,254)	(53,739)
Total	$ (128,703)	$1,246,022	$1,374,470

(1) Previously reported amounts have been restated for successful efforts method of accounting for oil and gas properties. See Note 2 of Notes to Consolidated Financial Statements.

(2) Approximately 68 percent, 73 percent and 75 percent of Natural Gas Operations revenues for the years 1986, 1985 and 1984, respectively, were from sales to Southern California Gas Company and Pacific Gas and Electric Company.

(3) Amounts for El Paso Hydrocarbons Company have been reclassified from Natural Gas Operations to Oil and Gas.

(4) Intersegment sales from Oil and Gas to Natural Gas Operations were $125 million, $216 million and $219 million for the years 1986, 1985 and 1984, respectively. Intersegment sales from Natural Gas Operations to Oil and Gas were $107 million, $242 million, and $258 million for the years 1986, 1985, and 1984, respectively.

(5) The non-cash, pretax Special Charge includes a writedown of the Company's oil and gas properties and a writeoff of surplus railroad assets. See Note 3 of Notes to Consolidated Financial Statements.

CONSOLIDATED SEGMENT INFORMATION

	Year Ended December 31,		
	1986	1985(1) (Restated)	1984(1) (Restated)
		(In Thousands)	
Identifiable Assets at End of Year:			
Railroad(2)	$ 5,952,148	$ 7,053,364	$ 6,660,154
Natural Gas Operations(3)	1,722,968	1,885,849	2,108,922
Oil and Gas(3)	2,271,662	2,130,534	1,882,269
Forest Products	130,509	135,390	136,063
Corporate and Other Operations(4)	573,669	1,050,864	499,657
Total	$10,650,956	$12,256,041	$11,287,065
Depreciation, Depletion and Amortization:			
Railroad(2)	$ 312,231	$ 234,411	$ 225,836
Natural Gas Operations(3)	67,262	98,622	98,367
Oil and Gas(3)	179,724	120,324	106,823
Forest Products	16,542	13,168	15,059
Corporate and Other Operations	20,587	11,106	4,816
Total	$ 596,346	$ 475,631	$ 450,901
Capital Expenditures			
Railroad	$ 351,196	$ 650,560	$ 610,855
Natural Gas Operations(3)	72,010	94,977	57,096
Oil and Gas(3)	116,063	334,846	232,111
Forest Products	12,238	15,208	12,225
Corporate and Other Operations	39,980	35,771	19,743
Total	$ 591,487	$ 1,131,362	$ 932,030

(1) Previously reported amounts have been restated for successful efforts method of accounting for oil and gas properties. See Note 2 of Notes to Consolidated Financial Statements.

(2) The retroactive application of the new method of depreciation is recognized effective as of January 1, 1986. See Note 2 of Notes to Consolidated Financial Statements.

(3) Amounts for El Paso Hydrocarbons Company have been reclassified from Natural Gas Operations to Oil and Gas.

(4) The 1985 amount includes approximately $730 million for the acquisition of Southland.

CONSOLIDATED STATEMENT OF INCOME

	Year Ended December 31,		
	1985	1984 (Restated)	1983 (Restated)
	(In Thousands, Except Per Share Amounts)		
Revenues	$6,941,413	$6,650,927	$6,156,337
Costs and Expenses	6,113,024	7,404,905	7,781,867
Special Charge (Note 3)	957,092	—	—
Operating Income (Loss)	(128,703)	1,246,022	1,374,470
Interest Expense	388,837	312,245	309,572
Other Income (Expense) — Net	62,996	106,419	(17,720)
Income (Loss) Before Income Taxes	(454,544)	1,040,196	1,047,178
Provision for Income Taxes (Note 5)	70,100	443,708	477,974
Income (Loss) Before Cumulative Effect of Change in Railroad Depreciation Method of Accounting	(524,644)	596,488	569,204
Cumulative Effect of Change in Railroad Depreciation Method of Accounting (Net of Deferred Income Tax of $314,150) (Note 2)	(335,841)	—	—
Net Income (Loss)	(860,485)	596,488	569,204
Dividend Requirements on Preferred Stock	33,028	65,637	76,996
Earnings (Loss) for Common Stock	$ (893,513)	$ 530,851	$ 492,208
Earnings (Loss) per Common Share:			
Earnings (Loss) Before Cumulative Effect of Change in Railroad Depreciation Method of Accounting	$ (7.53)	$ 7.19	$ 6.63
Cumulative Effect of Change in Railroad Depreciation Method of Accounting (Note 2)	(4.54)	—	—
Earnings (Loss) per Common Share	$ (12.07)	$ 7.19	$ 6.63
Pro Forma Net Income and Earnings per Common Share, Assuming Retroactive Effect of Change in Railroad Depreciation Method of Accounting:			
Net Income		$ 556,701	$ 525,169
Earnings per Common Share		$ 6.65	$ 6.04

See accompanying Accounting Policies and Notes to Consolidated Financial Statements.

CONSOLIDATED STATEMENT OF RETAINED EARNINGS

	Year Ended December 31,		
	1986	1985 (Restated)	1984 (Restated)
	(In Thousands)		
Balance, Beginning of Year, as previously reported			$2,937,171
Retroactive Restatement (Note 2):			
Change to Successful Efforts Accounting for Oil and Gas Properties			(32,368)
Balance, Beginning of Year, as restated	$3,714,484	$3,317,925	2,904,803
Net Income (Loss)	(860,485)	596,488	569,204
Cash Dividends Declared:			
Preferred Stock—Redeemable (Note 6):			
$10 par value	(663)	(1,302)	(1,107)
$9 Series, no par value	(689)	(4,820)	(4,590)
$2.125 Series, no par value	(639)	(3,408)	(2,639)
Adjustable Rate Series, no par value	(20,847)	(42,140)	(38,086)
Redeemable Preferred Stock of Subsidiary (Note 7)	(4,249)	(25,320)	(29,141)
Common Stock — Per Share:			
1986, $1.30; 1985, $1.45; 1984, $1.10	(95,944)	(106,552)	(80,952)
Acquisition of preferred stock (Notes 6 and 7)	(4,964)	(16,536)	863
Other	(296)	149	(230)
Balance, End of Year	$2,725,678	$3,714,484	$3,317,925

See accompanying Accounting Policies and Notes to Consolidated Financial Statements.

CONSOLIDATED BALANCE SHEET

	December 31,	
	1986	1985 (Restated)
	(In Thousands)	
ASSETS		
Current Assets:		
Cash and Short-term Investments	$ 78,381	$ 64,137
Accounts Receivable	937,875	1,118,021
Recoverable Excess Gas Costs	158,385	54,463
Material, Supplies and Inventories	260,582	386,456
Other Current Assets	43,242	42,724
	1,478,465	1,605,801
Properties (Notes 2, 3 and 4):		
Railroad	7,977,406	8,582,279
Natural Gas Operations	1,410,650	1,356,829
Oil and Gas	2,586,150	2,159,128
Other	338,741	321,087
	12,312,947	12,619,323
Accumulated Depreciation, Depletion and Amortization	3,612,376	2,992,925
Properties — Net	8,700,571	9,626,398
Other Assets (Note 9)	471,920	1,023,842
Total Assets	$10,650,956	$12,256,041
LIABILITIES		
Current Liabilities:		
Accounts and Wages Payable	$ 1,117,814	$ 1,171,641
Accrued Interest	116,437	86,942
Taxes Payable	125,167	144,937
Other Current Liabilities	101,545	169,469
Current Portion of Deferred Income Taxes	50,047	7,290
Current Portion of Long-term Debt	309,349	246,456
	1,822,359	1,828,665
Long-term Debt (Note 4)	3,393,812	3,117,961
Other Liabilities and Deferred Credits	397,378	240,646
Deferred Income Taxes (Note 5)	1,441,347	2,037,890
PREFERRED STOCK — REDEEMABLE (Note 6)		
$10 par value	17,201	15,464
$9 Series, no par value	—	40,800
$2.125 Series, no par value	—	31,187
Adjustable Rate Series, no par value	—	317,474
	17,201	407,925
Redeemable Preferred Stock of Subsidiary (Note 7)	44,545	110,925
COMMON STOCKHOLDERS' EQUITY		
Common Stock, without par value (Authorized 300,000,000 shares; issued 1986, 75,622,872 shares; 1985, 75,557,266 shares) (Notes 4 and 8)	881,214	875,783
Retained Earnings (Note 4)	2,725,678	3,714,484
	3,606,892	4,590,267
Cost of treasury stock (1986, 1,839,567 shares; 1985, 1,977,276 shares)	72,578	78,260
Common Stockholders' Equity	3,534,314	4,512,007
Total Liabilities, Preferred Stock and Common Stockholders' Equity	$10,650,956	$12,256,041

See accompanying Accounting Policies and Notes to Consolidated Financial Statements.

CONSOLIDATED STATEMENT OF CHANGES IN FINANCIAL POSITION

	Year Ended December 31,		
	1986	1985 (Restated)	1984 (Restated)
	(In Thousands)		
Funds Provided by Operations:			
Net Income (Loss)	$ (860,485)	$ 596,488	$ 569,204
Items Not Affecting Cash:			
Depreciation, Depletion and Amortization	596,346	475,631	450,901
Deferred Income Taxes	51,466	404,695	394,743
Unsuccessful Exploration Costs	51,909	118,859	74,482
Other(1)	103,581	(8,815)	23,904
Special Charge(2)	957,092	—	—
Change in Railroad Depreciation Method of Accounting(3)	335,841	—	—
Funds Provided by Operations	1,235,750	1,586,858	1,513,214
Other Funds Provided (Used):			
Salvage, Property Dispositions	146,498	47,475	58,461
Working Capital Changes:			
Accounts Receivable	180,146	44,371	7,003
Recoverable Excess Gas Costs	(103,922)	48,279	176,441
Material, Supplies and Inventories	65,874	65,611	(2,961)
Other Current Assets	(516)	28,961	(13,186)
Accounts and Wages Payable	(53,827)	(246,076)	118,784
Accrued Interest	29,495	24,809	(4,099)
Taxes Payable	(19,770)	(33,989)	17,429
Other Current Liabilities	(67,924)	34,713	43,586
Additions to Properties	(591,487)	(1,131,362)	(932,030)
Other(4)	(199,858)	(1,017,235)	(81,645)
Funds Provided (Used) Before Financing Activities	622,457	(547,585)	900,997
Financing Activities:			
Proceeds from Long-term Financing	875,000	854,173	218,756
Reductions in Long-term Debt and Preferred Stock	(1,342,180)	(350,301)	(733,237)
Dividends Paid	(152,146)	(162,049)	(130,268)
Common and Preferred Stock Issued	5,431	7,791	7,000
Treasury Stock Transactions — Net	5,682	7,812	(50,030)
Total Financing Activities	(608,213)	357,426	(687,479)
Increase (Decrease) in Cash and Short-term Investments	14,244	(190,159)	203,518
Cash and Short-term Investments:			
Beginning of Year	64,137	254,296	50,778
End of Year	$ 78,381	$ 64,137	$ 254,296

(1) The 1986 amount includes $122 million for coal rate litigation reserves, including interest.

(2) The non-cash, pre-tax Special Charge includes a writedown of the Company's oil and gas properties and a writeoff of surplus railroad assets. See Note 3 of Notes to Consolidated Financial Statements.

(3) The retroactive application of the new method of depreciation is recognized effective as of January 1, 1986. See Note 2 of Notes to Consolidated Financial Statements.

(4) The 1985 amount includes approximately $730 million for the acquisition of Southland.

See accompanying Accounting Policies and Notes to Consolidated Financial Statements.

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ACCOUNTING POLICIES

Principles of Consolidation

The consolidated financial statements include the accounts of Burlington Northern Inc. (the "Company") and its majority owned subsidiaries, except for a wholly owned commercial real estate development subsidiary, which is accounted for by the equity method. Southland Royalty Company ("Southland") is accounted for by the equity method in 1985. All significant intercompany transactions are accounted for at market prices and have been eliminated.

Recoverable Excess Gas Costs

The differences between actual purchased gas costs and the averages of these costs included in currently effective gas sales rates of El Paso Natural Gas Company ("EPNG") are deferred and amortized to income in the period in which they are recovered through surcharges in gas sales rates permitted by the Federal Energy Regulatory Commission ("FERC"). The surcharges are adjusted at six-month intervals by filings with the FERC.

Property

In 1986, the Company adopted a method of depreciation for the majority of its railroad transportation properties that closely approximates a unit method versus the composite method of depreciation previously used. All other railroad transportation properties and railroad equipment are depreciated on a straight-line basis over estimated useful lives. A periodic review of rates and accumulated depreciation is performed and appropriate adjustments are recorded. Significant premature railroad retirements are recorded as gains or losses at the time of their occurrence. These include major casualty losses, abandonments, sales and identification of obsolete assets. Natural gas transmission properties are depreciated on a composite straight-line basis over estimated useful lives. The costs of properties retired or sold is eliminated from the asset and related accumulated depreciation, depletion and amortization accounts. No gain or loss is recognized upon retirement of properties depreciated under the composite method except in extraordinary circumstances. Gains or losses from disposal of all other properties are recognized currently. Expenditures for maintenance, repairs and minor renewals necessary to maintain properties in operating condition are expensed as incurred. Major replacements and renewals are capitalized. All properties are stated at cost.

Oil and Gas

In 1986, the Company changed the method of accounting for its oil and gas properties from the full cost method to the successful efforts method. Under this new method, all development costs are capitalized and amortized on a unit-of-production basis over the life of remaining proved developed reserves. Costs of drilling exploratory wells are initially capitalized, but charged to expense if and when a well is determined to be unsuccessful. In addition, the Company limits the total amount of unamortized capitalized costs to the present value of future net revenues, based on current prices and costs, discounted at 4 percent.

Material, Supplies and Inventories

Material and supplies, which account for approximately 72 percent of material, supplies, and inventories, are valued at the lower of average cost or market. Inventories held for sale, other than gas in storage, are valued at the lower of "first-in, first-out" cost or market. Gas in storage inventories are valued on the "last-in, first-out" basis.

Forest Products

Property taxes and costs of maintaining forests are charged to expense as incurred. Reforestation costs are capitalized and included as a cost of timber when harvested.

Income Taxes

[illegible] provision for income taxes includes deferred taxes resulting from items reported in different periods for tax and financial statement purposes. Investment tax credit was repealed pursuant to the 1986 Tax Reform Act with the exception of transitional property. Investment tax credits are accounted for under the "flow-through" method.

Earnings per Common Share

Earnings per common share are based on the weighted average number of common shares outstanding during each year. The dilutive effect of stock options outstanding and convertible subordinated notes is not significant.

NOTES TO CONSOLIDATED FINANCIAL STATEMENTS

1. Segment Information

The Company conducts business in several industry segments. Information for each segment is located on pages 23 and 24 of this report. Amounts for El Paso Hydrocarbons Company have been reclassified from Natural Gas Operations to Oil and Ga

2. Changes in Accounting Methods

Effective June 30, 1986, the Company changed the method of accounting for its oil and gas properties from the full cost method to the successful efforts method.

Although the full cost method continues to be a generally accepted accounting principle, the Financial Accounting Standards Board has expressed a preference for the successful efforts method, and management believes the successful efforts method is a more appropriate measure of the results of the Company's oil and gas operations under the present circumstances. Accordingly, financial statements of prior years have been restated to comply with the new method as follows:

	Year ended December 31,	
	1985	1984
	(In Thousands, Except Per Share Amounts)	
Net income, as previously reported	$658,295	$608,106
Adjustment for change to successful efforts method of accounting	(61,807)	(38,902)
Net income, as restated	$596,488	$569,204
Earnings per Common Share:		
As previously reported	$ 8.03	$ 7.15
Adjustment for change to successful efforts method of accounting	(0.84)	(0.52)
Earnings per Common Share, as restated	$ 7.19	$ 6.63

In addition, retained earnings as of December 31, 1983 have been reduced by $32 million to reflect the method's effect on 1983 and prior years.

Also in the second quarter of 1986, the Company adopted a method of depreciation for the majority of its railroad transportation properties that closely approximates a unit method rather than the composite method of depreciation previously used. This method was adopted to more accurately reflect physical use of assets in the current deregulated transportation environment. The new method has been applied to prior years property acquisitions resulting in a $336 million after tax charge to the first quarter 1986. The new method is also effective for the full year 1986 which had the effect of increasing net loss for 1986 by $41 million, $0.58 per share.

3. Special Charge

The non-cash, pretax Special Charge of $957 million includes a writedown of the Company's oil and gas properties and a writeoff of surplus railroad assets. The after tax impact of this Special Charge increased 1986 Net Loss by $802 million, $10.83 per share.

At June 30, 1986 the Company's unamortized oil and gas capitalized costs exceeded the present value of future net revenues based on the newly adopted successful efforts method of accounting for oil and gas properties. As a result, the Company recorded a $605 million pretax charge to reflect the substantial decline in oil and gas prices.

Also in the second quarter of 1986, the Company conducted a review of its railroad physical properties. The Special Charge includes a $352 million provision for surplus, obsolete or otherwise unproductive assets including locomotives, rolling stock and abandoned track.

4. Long-Term Debt and Lease Obligations

Long-term debt outstanding is as follows:

	December 31,	
	1986	1985
	(In Thousands)	
Burlington Northern Inc		
Notes Payable, 14¼%, due 1992	$ 100,000	$ 100,000
Debentures, 11¾%, due 1996 to 2015	250,000	250,000
Notes Payable, 9⅝%, due 1996	300,000	—
Debentures, 9%, due 1997 to 2016	200,000	—
Revolving Credit and Term Loan, 8.8%	—	80,000
Commercial Paper	429,680	695,288
Burlington Northern Railroad Company:		
General Mortgage Bonds, 2½% to 3¼%, due 1990 to 2010	110,000	110,000
Prior Lien Mortgage Bonds, 4%, due 1997	69,921	69,921
General Lien Mortgage Bonds, 3%, due 2047	47,777	47,777
First and Refunding Mortgage Bonds, 3%, due 1990	14,437	14,737
Consolidated Mortgage Bonds, 5¼% to 12½%, due 1989 to 2008	528,234	280,205
First Mortgage Bonds, Series A, 4%, due 1997	37,489	39,239
Income Debentures, Series A, 5%, due 2006	24,075	24,494
Mortgage Notes, 6¾%, due serially to 1992	3,900	4,050
Equipment and Other Obligations, 6% to 14¼%, due serially to 2018	486,944	559,593
El Paso Natural Gas Company		
Debentures, 6.75% to 16.7%, due 1987 to 2011	552,654	610,572
Senior Notes Payable to Insurance Companies, 17¼%, due 1987	79,000	150,000
Notes Payable, 15¾%, due 1992	100,000	100,000
Other:		
Convertible Subordinated Notes, 13%, due 1992	50,000	50,000
Senior Notes Payable to Insurance Companies, 11¾%, due 1987 to 1992	37,500	43,750
Notes Payable to Insurance Companies, 8.95% to 12.25%, due 1987 to 1993	179,036	—
Other, 5½% to 18%, due 1987 to 1998	7,189	51,971
Capital Lease Obligations	117,501	125,259
Unamortized Discount	(22,178)	(22,417)
Total	3,703,161	3,364,439
Less Current Portion	309,349	246,456
Long-term Debt	$3,393,812	$3,117,983

A group of banks has committed to a $900 million Revolving Credit Agreement which expires March 31, 1995. The commitment by lenders to make advances reduces by $40 million each quarter, commencing June 30, 1991. Annual fees are ¼ of 1 percent of the unused portion of the commitment. Another group of banks has committed to a $450 million Facility Agreement which expires on May 6, 1991. Annual fees are 1/10 of 1 percent of the unused portion of the commitment. The aggregate of borrowings under these agreements and commercial paper outstanding cannot exceed $1.35 billion. At

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the Company's option, interest on borrowings is based on either prime rates, domestic money market rates, or Eurodollar rates. Under the most restrictive covenants of these agreements, retained earnings of $398 million are available for payment of dividends. Unused long-term commitments under these agreements are available to cover certain debt due within one year. Commercial paper, all of which is due within nine months, is therefore classified as long-term debt. At December 31, 1986, the interest rate on commercial paper was approximately 6 percent.

The Company has Interest Rate Exchange Agreements for the purpose of converting the effective interest rate on floating rate facilities to fixed interest rates. Under the terms of these agreements, the Company has an effective interest rate of approximately 12.25 percent on $250 million of floating rate obligations through 1991.

In February 1986, the Company issued $300 million of 9¼% Notes, due 1996. Additionally, in March 1986, the Company filed a $400 million shelf registration statement for issuance of debt securities, under which $200 million of 9% Debentures, due 2016, were issued in April 1986.

In October 1986, Railroad issued $275 million of Consolidated Mortgage 9¼% Bonds, Series H, due 2006. The Series H Bonds are not redeemable prior to maturity and are not entitled to any sinking fund.

In October 1986, EPNG issued $100 million of 9¼% Debentures, due 2011. Annual sinking fund requirements for the Debentures begin in 1997.

The Convertible Subordinated Notes are convertible into common stock of the Company at $51.50 per share. Accordingly, 969,271 shares of common stock have been reserved in treasury.

Aggregate long-term debt maturities for 1987 through 1991 are $309,349,000, $201,861,000, $205,109,000, $192,547,000, and $132,665,000, respectively. These amounts do not include repayment requirements that arise when mortgaged property is sold. At December 31, 1986, $3,673,000 principal amount of treasury bonds is available to reduce the annual repayment requirements specified above.

Substantially all of Burlington Northern Railroad Company's properties and certain other assets are pledged as collateral to or are otherwise restricted under long-term debt agreements.

Lease Obligations

The Company has substantial lease commitments for railroad track structure and equipment, highway and data processing equipment, office buildings and a taconite dock facility. Substantially all of these leases provide the option to purchase the equipment at fair market value at the end of the lease.

Certain noncancellable leases are classified as capital leases and are included in property. The consolidated balance sheet at December 31, 1986 and 1985, includes $150,805,000 and $147,141,000, respectively, of properties and $52,974,000 and $41,011,000, respectively, of accumulated amortization relating to capital leases.

Lease rental expense for operating leases is $144,528,000, $136,924,000, and $154,216,000 for the years ended December 31, 1986, 1985 and 1984, respectively.

Minimum annual rental commitments at December 31, 1986, are as follows:

Year Ending December 31,	Capital Leases	Operating Leases
	(In Thousands)	
1987	$ 26,439	$ 132,864
1988	22,240	122,958
1989	17,827	115,251
1990	16,691	106,568
1991	15,451	98,806
Thereafter	85,138	690,054
Total	183,786	$1,266,501
Less amount representing interest	66,285	
Present value of minimum lease payments	$117,501	

5. Income Taxes

The provision for income taxes, excluding the effect of the change in Railroad depreciation method of accounting, is as follows:

	Year Ended December 31,		
	1986	1985 (Restated)	1984 (Restated)
		(In Thousands)	
Current			
Federal	$18,015	$ 20,602	$ 36,496
State	619	18,411	46,733
	18,634	39,013	83,231
Deferred			
Federal	54,609	372,808	389,636
State	(3,143)	31,887	5,107
	51,466	404,695	394,743
Total	$70,100	$443,708	$477,974

Reconciliation of statutory income tax rate to the effective income tax expense (benefit) rate is as follows:

	Year Ended December 31,		
	1986	1985 (Restated)	1984 (Restated)
Statutory expense (benefit) rate	(46.0)%	46.0%	46.0%
Investment tax credit	(0.6)	(5.9)	(4.4)
Capital gain tax rates	(0.7)	(1.9)	(1.7)
State income taxes net of federal tax benefit	(0.3)	2.6	2.7
Acquisition adjustments	4.0	2.7	2.6
Writedown of oil and gas properties	61.2	—	—
Dividend exclusion	(2.3)	—	—
Other	0.1	(0.8)	0.4
Effective Rate	15.4%	42.7%	45.6%

Deferred tax expense consists of the following:

	Year Ended December 31,		
	1986	1985 (Restated)	1984 (Restated)
		(In Thousands)	
Excess of tax over book depreciation	$161,974	$267,151	$253,388
Writeoff of railroad assets	(162,149)	—	—
Accruals for casualties, claims and expenses not deductible in the current year	(27,326)	52,318	(82,080)
Intangible drilling costs	(25,510)	(14,831)	(22,090)
Use of tax operating loss carryovers	1,835	11,662	148,061
Investment credit carryovers	57,834	45,739	136,850
Recoverable excess gas costs	(17,264)	(14,403)	(84,228)
Other	62,072	57,019	14,842
Total	$ 51,466	$404,695	$394,743

Investment tax credits generated for the years 1986 to 1984 are $5.0 million, $78.9 million and $46.4 million, respectively. As of December 31, 1986, approximately $43.7 million of investment tax credit carryovers are available to offset future tax liabilities and approximately $58.5 million of net operating loss carryovers are available to offset future taxable income for up to 15 years. Approximately $10.0 million of the investment tax credit carryovers and all of the net operating loss carryovers are restricted under the separate return limitation year rules of the Internal Revenue Service Regulations. The benefits of the investment tax credit and net operating loss carryovers have been recognized for accounting purposes.

As a result of the Tax Reform Act of 1986, the provision for income taxes for the fourth quarter 1986 was adjusted to reflect the loss of approximately $32 million in investment tax credit which had been reflected in the tax provision in the first three quarters of 1986. Additionally, future utilization of the investment credit carryovers available as of December 31, 1986, will be reduced by 17.5 percent in 1987 as a result of the Act. The Tax Reform Act of 1986 will not have a significant effect on the Company's future financial condition or results of operations.

6. Preferred Stock — Redeemable

Preferred stock consists of the following:

	1986		1985		1984	
	Shares Outstanding	Amount (Thousands)	Shares Outstanding	Amount (Thousands)	Shares Outstanding	Amount (Thousands)
$10 par value, authorized 2,114,669 shares:						
Balance, beginning of year	1,846,448	$ 18,464	1,966,501	$ 19,665	2,058,820	$ 20,588
Acquired during year	126,127	1,263	120,053	1,201	92,319	923
Balance, end of year	1,720,121	$ 17,201	1,846,448	$ 18,464	1,966,501	$ 19,665
No par value, authorized 25,000,000 shares:						
$9 Series:						
Balance, beginning of year	406,000	$ 40,800	510,000	$ 51,000	510,000	$ 51,000
Acquired during year	406,000	40,800	102,000	10,200	—	—
Balance, end of year	—	$ —	408,000	$ 40,800	510,000	$ 51,000
$2.125 Series:						
Balance, beginning of year	1,247,466	$ 31,187	1,336,166	$ 33,423	1,335,895	$ 33,416
Issued on exercise of stock options	660	5	—	—	271	7
Acquired during year	1,248,126	31,192	88,700	2,236	—	—
Balance, end of year	—	$ —	1,247,466	$ 31,187	1,336,166	$ 33,423
Adjustable Rate Series:						
Balance, beginning of year	6,614,050	$317,474	7,015,878	$336,762	7,033,288	$337,596
Acquired during year	6,613,000	317,424	401,100	19,253	—	—
Adjusted for fractional shares	1,050	50	728	35	17,410	836
Balance, end of year	—	$ —	6,614,050	$317,474	7,015,878	$336,762

$10 Par Value Preferred Stock, Cumulative

The Company is required to retire 123,458 shares annually, through redemption at par or cancellation of shares acquired through open-market purchases.

$9 Series No Par Value Preferred Stock, Cumulative

The Company redeemed all of the outstanding stock in 1986, including 306,000 shares redeemed early at $102 per share and 102,000 shares at par.

$2.125 Series No Par Value Preferred Stock, $25 Redemption Value, Cumulative

The Company redeemed all of the outstanding stock at $26.40 per share in 1986.

Adjustable Rate Series No Par Value Preferred Stock, $48 Redemption Value, Cumulative

The Company redeemed all of the outstanding stock at $48 per share in 1986.

No Par Value Preferred Stock and Class A Preferred Stock Without Par Value—Unissued

At December 31, 1986, the Company has available for issuance 25,000,000 shares of No Par Value Preferred Stock and 50,000,000 shares of Class A Preferred Stock Without Par Value. The Board of

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Directors has the authority to issue such stock in one or more series, to fix the number of shares and to fix the designations and the powers. On July 10, 1986, the Board of Directors designated a series of 800,000 shares of Class A Preferred Stock Without Par Value as Series A Junior Participating Class A Preferred Stock. Each one one-hundredth of a share will have dividend and voting rights approximately equal to those of one share of Common Stock of the Company. In addition, on July 10, 1986, the Board of Directors declared a dividend distribution of one Right for each outstanding share of Common Stock of the Company. The Rights become exercisable if, without the Company's prior consent, a person or group acquires securities having 20 percent or more of the voting power of all of the Company's voting securities or announces a tender offer which would result in such ownership. Each Right, when exercisable, entitles the registered holder to purchase from the Company one one-hundredth of a share of Series A Junior Participating Class A Preferred Stock at a price of $190 per one one-hundredth of a share, subject to adjustment. If after the Rights become exercisable, the Company were to be acquired through a merger, each Right would permit the holder to purchase, for the exercise price, stock of the acquiring company having a value of twice the exercise price. In addition, if any person acquires 25 percent or more of the Company (other than as a result of a cash offer for all shares), each Right not owned by the holder of such 25 percent would permit the purchase, for the exercise price, of stock of the Company having a value of twice the exercise price. The Rights may be redeemed by the Company under certain circumstances until their expiration date for $0.05 per Right.

The preferred stock redemption requirements for 1987 through 1991 are $1,235,000 per year.

Redeemable Preferred Stock of Subsidiary

The redeemable preferred stock of EPNG consists of the following at December 31

	1986		1985		1984	
	Shares Outstanding	Amount (Thousands)	Shares Outstanding	Amount (Thousands)	Shares Outstanding	Amount (Thousands)
Preferred Stock, cumulative, no par value, 12,500,000 shares authorized						
5¼%, Series of 1965	267,200	$26,720	297,200	$ 29,720	327,200	$ 32,720
10¾%, Series of 1970			186,766	18,678	187,682	18,768
8¼%, Series of 1972	178,250	17,825	184,000	18,400	189,750	18,975
9.4%, Series of 1978			441,270	44,127	608,780	60,878
15%, Series of 1981					2,000,000	50,000
Preference Stock, cumulative, no par value, 10,000,000 shares authorized						
14%, Series of 1982					3,000,000	75,000
Total		$44,545		$110,925		$256,341

In February 1986, EPNG redeemed all of the outstanding stock of the 10¾% Cumulative Preferred Stock, Series of 1970 at $102.50 per share and its 9.4% Cumulative Preferred Stock, Series of 1978 at $105.44 per share.

In September 1985, EPNG redeemed all of the outstanding stock of the 15% Cumulative Preferred Stock, Series of 1981 at $27.95 share and its 14% Cumulative Preference Stock, Series of 1982 at $28.50 per share.

The aggregate redemption value of EPNG's redeemable preferred stock is $45 million at December 31, 1986. The redemption requirements are $3,575,000 for 1987 and $4,150,000 per year for 1988 through 1991.

8. Common Stock and Stock Options

Common and treasury stock activity is as follows:

	1986		1985		1984	
	Shares Outstanding	Amount (In Thousands)	Shares Outstanding	Amount (In Thousands)	Shares Outstanding	Amount (In Thousands)
Common stock:						
Balance, beginning of year	75,557,266	$875,783	75,386,844	$867,992	75,250,828	$860,999
Exercise of Stock options	65,606	5,431	170,422	7,791	136,016	6,993
Balance, end of year	75,622,872	$881,214	75,557,266	$875,783	75,386,844	$867,992
Treasury stock:						
Balance, beginning of year	1,977,276	$ 78,260	2,186,915	$ 86,072	951,244	$ 27,042
Acquired (Issued), net	(138,709)	(5,682)	(209,639)	(7,812)	1,235,671	59,030
Balance, end of year	1,838,567	$ 72,578	1,977,276	$ 78,260	2,186,915	$ 86,072

Under the Company's stock option plans, options may be granted to officers and key salaried employees at fair market value at the date of grant, exercisable in whole or part by the optionee after completion of one year of continuous employment from the grant date. For incentive stock options, the difference between the option price and the market value on the date exercised is not taxable to the employee until the stock is sold. The Company also grants stock appreciation rights ("SARs") to certain holders of stock options. SARs are exercisable during the same period as the options. The option holder can elect to exercise either the option or the SAR. SARs entitle an option holder to receive a payment equal to the difference between the option price and the fair market value of the common stock at the date of exercise of the SAR. To the extent the SAR is exercised, the related option is cancelled and to the extent the option is exercised the related SAR is cancelled.

Activity in stock option plans for 1984, 1985 and 1986 is as follows:

	Options	SARs	Exercise Price per Share
Balance, January 1, 1984	1,101,286	195,132	$ 6.17 to $49.31
Granted	288,300	75,800	42.56 to 45.88
Exercised	220,829	37,200	6.17 to 35.16
Cancelled	60,636	32,042	32.69 to 43.22
Balance, December 31, 1984	1,108,121	201,690	6.17 to 49.31
Granted	281,250	77,750	— 52.00
Exercised	367,221	98,750	6.17 to 45.88
Cancelled	114,550	17,400	22.09 to 52.00
Balance, December 31, 1985	907,600	163,290	9.59 to 52.00
Granted	196,200	57,700	68.19 to 70.19
Exercised	227,838	63,836	9.59 to 52.00
Cancelled	90,788	16,854	10.22 to 68.38
Balance, December 31, 1986	785,174	140,300	9.59 to 70.19

At December 31, 1986, 588,974 options and 82,600 SARs are exercisable at prices of $9.59 to $52.00 per share. At December 31, 1986 and 1985, 1,160,010 and 1,311,810 shares, respectively, are available for additional grant under the plans.

Shares issued upon exercise of options under one of the plans may be issued from treasury shares or from authorized but unissued shares. The Company has a formal program to systematically repurchase treasury shares for the plan.

9. Acquisition of Southland Royalty Company

On December 13, 1985, Southland became a wholly owned subsidiary of the Company pursuant to an Agreement of Merger between the Company and Southland dated as of November 21, 1985 and following a tender offer for all the outstanding shares of common stock of Southland commenced by the Company on October 22, 1985. The aggregate consideration for the common stock of Southland acquired by the Company was approximately $730 million. Southland is accounted for by the equity method in 1985, including appropriate purchase accounting adjustments.

10. Pension Plans

The Company's pension plans are non-contributory defined benefit plans covering substantially all non-union employees. The benefits are based on years of credited service and highest five year average compensation levels. Contributions to the plans are based upon the Attained Age Normal Frozen Initial Liability actuarial funding method and are limited to amounts that are currently deductible for tax purposes. Contributions are intended to provide not only for benefits attributed to service to date but also for those expected to be earned in the future.

Effective January 1, 1986, the Company adopted Statement of Financial Accounting Standards No. 87, "Employers' Accounting for Pensions". Adoption of this Statement, along with a change in the discount rate from 9 percent to 10 percent, had the effect of reducing 1986 pension cost by $15,410,000. Pension cost was $34,086,000, $42,495,000 and $56,780,000 in 1986, 1985 and 1984, respectively.

The following table sets forth the plans' funded status and amounts recognized in the Company's consolidated balance sheet and income statement (In Thousands):

	December 31, 1986
Actuarial present value of benefit obligations:	
Accumulated benefit obligation, including vested benefits of $771,095	$ 793,130
Projected benefit obligation for service rendered to date	$ 970,429
Plan assets at fair value, primarily marketable equity securities	(818,416)
Projected benefit obligation in excess of plan assets	152,013
Unrecognized net loss	(30,089)
Unamortized net transition obligation	(118,058)
Net accrued pension cost	$ 3,866
Net pension cost for 1986 included the following components:	
Service cost—benefits earned during the period	$ 14,124
Interest cost on projected benefit obligation	83,127
Actual return on plan assets	(130,365)
Net amortization and deferral	67,200
Net pension cost	$ 34,086

The weighted average discount rate and rate of increase in future compensation levels used in determining the actuarial present value of the projected benefit obligation as of December 31, 1986 were 9.25 percent and 6.0 percent, respectively. The expected long-term rate of return on plan assets was 10.0 percent.

The corresponding assumptions used in the determination of the net transition obligation at January 1, 1986, and the 1986 net pension cost were a 10.0 percent discount rate, a 6.0 percent rate of increase in future compensation levels, and a 10.0 percent expected long-term rate of return on plan assets.

As determined under prior year accounting policies, the actuarial present value of accumulated plan benefits as of January 1, 1985 was $693,578,000, including $657,548,000 of vested benefits. The amounts reflected an assumed rate of return of 9.0 percent. Net assets available for plan benefits as of January 1, 1985 were $599,511,000.

11. Commitments and Contingent Liabilities

In October 1986, Railroad entered into an electrical power purchase agreement under which payment is based on the number of megawatt hours of energy consumed, subject to a specified take-or-pay minimum. The agreement requires a number of locomotives sufficient to provide the necessary megawatt hours to Railroad. Railroad's absolute, annualized minimum payment obligation is $12,520,000 over the 15 year term of the agreement. This payment will vary upward depending on mechanical practices, performance and utilization. Based on current availability and usage, Railroad's payment in 1987 will equal or exceed $29,000,000. As of December 31, 1986, Railroad had purchased $1,900,000 of electrical power under this agreement.

There are no other commitments or contingent liabilities which would have a materially adverse effect on the financial position or the results of operations. See "Legal Proceedings", pages 13, 14 and 15, and "Natural Gas Operations", pages 7, 8, 9 and 10 for information concerning litigation and other matters.

REPORT OF INDEPENDENT CERTIFIED PUBLIC ACCOUNTANTS

To the Stockholders and Directors of
Burlington Northern Inc.

We have examined the consolidated balance sheets of Burlington Northern Inc. at December 31, 1986 and 1985, and the related consolidated statements of income, retained earnings and changes in financial position for each of the three years in the period ended December 31, 1986. Our examinations were made in accordance with generally accepted auditing standards and, accordingly, included such tests of the accounting records and such other auditing procedures as we considered necessary in the circumstances.

In our opinion, the financial statements referred to above present fairly the consolidated financial position of Burlington Northern Inc. at December 31, 1986 and 1985, and the consolidated results of its operations and changes in its financial position for each of the three years in the period ended December 31, 1986, in conformity with generally accepted accounting principles applied on a consistent basis after restatement for the change, with which we concur, in the method of accounting for oil and gas properties, and except for the change, with which we concur, in the method of accounting for railroad transportation properties; such changes are described in Note 2 to the financial statements.

Coopers & Lybrand

COOPERS & LYBRAND

Seattle, Washington
January 22, 1987

SUPPLEMENTAL OIL AND GAS DISCLOSURES—Unaudited

The supplemental data presented herein reflects all of the Company's oil and gas properties excluding those of Southland Royalty Company ("Southland") in prior years unless otherwise indicated.

Capitalized costs for oil and gas producing activities consist of the following:

	December 31,	
	1986	1985(1)(2)
	(In Thousands)	
Proved properties	$2,247,813	$2,656,489
Unproved properties	116,996	369,136
	2,364,809	3,025,625
Accumulated depreciation, depletion and amortization ("DD&A")	443,641	275,974
Net capitalized costs	$1,921,168	$2,749,651

Costs incurred for oil and gas property acquisition, exploration and development activities are as follows:

	Year Ended December 31,		
	1986	1985	1984
		(In Thousands)	
Property acquisition	$25,117	$ 85,989	$ 66,755
Exploration	30,414	71,311	96,564
Development	40,500	145,528	51,395
Total costs incurred	$96,031	$302,828	$214,714

Results of operations for oil and gas producing activities are as follows:

	Year Ended December 31,		
	1986	1985(1)	1984(1)
		(In Thousands)	
Net revenues	$ 405,751	$412,322	$406,669
Production costs	120,155	78,325	86,433
Oil and gas property writedown(3)	604,594	—	—
Exploration and impairment	58,095	118,859	74,462
Operating expenses	67,068	56,894	44,719
DD&A	158,658	105,335	95,695
	1,008,570	359,213	299,308
Operating income (loss)	(602,819)	53,109	107,361
Income tax provision	28,840	41,691	68,238
Results of operations for oil and gas producing activities	$(631,659)	$ 11,418	$ 39,123
Equity in Southland oil and gas producing activities		$ 1,000	

(1) Previously reported amounts have been restated for comparability with the newly adopted successful efforts method of accounting for oil and gas properties. See Note 2 of Notes to Consolidated Financial Statements.

(2) Includes Southland.

(3) See Note 3 of Notes to Consolidated Financial Statements.

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The following table reflects estimated quantities of proved oil and gas reserves. These reserves have been reduced for royalty interests owned by others. These reserves, virtually all located in the United States, have been estimated by the Company's engineers and geologists.

	Oil (MMBbls)	Gas (BCF)
Proved Developed and Undeveloped Reserves		
January 1, 1984	39.7	2,554
Revision of previous estimates	1.0	(34)
Extensions, discoveries and other additions	9.0	102
Production	(4.7)	(105)
December 31, 1984	45.0	2,517
Revision of previous estimates	(0.4)	43
Extensions, discoveries and other additions	10.5	50
Production	(5.0)	(107)
Purchases of reserves in place	0.2	80
Southland acquisition	55.6	444
December 31, 1985	105.9	3,027
Revision of previous estimates	(7.7)	(36)
Extensions, discoveries and other additions	6.2	61
Production	(11.1)	(145)
December 31, 1986	93.3	2,887
Proved Developed Reserves		
January 1, 1984	29.5	1,681
December 31, 1984	35.1	1,591
December 31, 1985	79.5	2,042
December 31, 1986	75.0	2,141

A summary of the standardized measure of discounted future net cash flows relating to proved oil and gas reserves is shown below. Future net cash flows are computed using year-end costs, sales prices and statutory tax rates (adjusted for permanent differences) that relate to the Company's existing proved oil and gas reserves.

	December 31,	
	1986	1985(1)
	(In Thousands)	
Future cash inflows	$5,451,000	$10,618,000
Less related future:		
Production costs	1,627,000	2,264,000
Development costs	318,000	440,000
Income taxes	1,093,000	3,548,000
Future net cash flows	2,413,000	4,366,000
10% annual discount for estimated timing of cash flows	1,406,000	2,504,000
Standardized measure of discounted future net cash flows	$1,007,000	$ 1,862,000

(1) Includes Southland.

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A summary of the changes in the standardized measure of discounted future net cash flows applicable to proved oil and gas reserves is as follows:

	1986	1985	1984
		(In Thousands)	
January 1,	$1,862,000	$1,411,000	$1,573,000
Revisions of previous estimates:			
Changes in prices and costs	(1,681,000)	(314,000)	(888,000)
Changes in quantities	(51,000)	73,000	(30,000)
Changes in rate of production	(103,000)	(55,000)	527,000
Additions to proved reserves resulting from extensions, discoveries and improved recovery, less related costs	46,000	114,000	177,000
Purchases of reserves in place	—	41,000	—
Southland acquisition	—	585,000	—
Accretion of discount	327,000	252,000	282,000
Sales of oil and gas, net of production costs	(288,000)	(317,000)	(354,000)
Net change in income taxes	982,000	75,000	144,000
Other	(87,000)	(3,000)	(20,000)
Net change	(855,000)	451,000	(162,000)
December 31,	$1,007,000	$1,862,000	$1,411,000

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QUARTERLY FINANCIAL DATA—Unaudited

	1986				1985			
	4th	3rd	2nd (Restated)	1st(1) (Restated)	4th(1)(2) (Restated)	3rd(1) (Restated)	2nd(1) (Restated)	1st(1) (Restated)
	(In Millions, Except per Share Amounts)							
Revenues	$1,610	$1,699	$1,678	$1,984	$2,089	$2,128	$2,094	$2,280
Special Charge(3)			957					
Operating Income (Loss)	143	282	(791)	237	282	349	314	301
Income (Loss) Before Cumulative Effect of Accounting Change	77	100	(785)	84	133	181	146	136
Cumulative Effect of Accounting Change				(336)				
Net Income (Loss)(4)	77	100	(785)	(252)	133	181	146	136
Earnings (Loss) per Common Share								
Cumulative Effect of Accounting Change				(4.54)				
Earnings (Loss) per Common Share	0.85	1.25	(10.72)	(3.55)	1.63	2.22	1.78	1.58
Dividends Declared per Common Share	0.50	0.40	0.40		0.75	0.35	0.35	
Common Stock Price Range								
High	64¼	64¼	74¼	82¼	72¼	87¼	82¾	57¾
Low	53¼	48¼	62¼	67	62	60	49¼	48¼

Revenues—As Previously Reported				$1,904				
Restatement for Southland(2)				80				
Revenues				$1,984				
Operating Income - As Previously Reported			$ 166	$ 270	$ 327	$ 363	$ 337	$ 328
Restatement for Southland(2)				11				
Restatement for Change in Depreciation Method(5)				(17)				
Restatement for Successful Efforts(1)				(27)	(45)	(14)	(23)	(27)
Special Charge(3)			957					
Operating Income (Loss)			$ (791)	$ 237	$ 282	$ 349	$ 314	$ 301
Net Income—As Previously Reported				$ 107	$ 157	$ 188	$ 158	$ 155
Restatement for Change in Depreciation Method(5)				(345)				
Restatement for Successful Efforts(1)				(14)	(24)	(7)	(12)	(19)
Net Income (Loss)				$ (252)	$ 133	$ 181	$ 146	$ 136
Earnings (Loss) per Common Share—As Previously Reported				$ 1.30	$ 1.95	$ 2.31	$ 1.92	$ 1.85
Restatement for Change in Depreciation Method(5)				(4.66)				
Restatement for Successful Efforts(1)				(0.19)	(0.32)	(0.09)	(0.14)	(0.27)
Earnings (Loss) per Common Share				$(3.55)	$ 1.63	$ 2.22	$ 1.78	$ 1.58

(1) Previously reported amounts have been restated for comparability with the newly adopted successful efforts method of accounting for oil and gas properties. See Note 2 of Notes to Consolidated Financial Statements.

(2) Results of operations for the fourth quarter of 1985 include Southland on the equity method of accounting. See Note 9 of Notes to Consolidated Financial Statements.

(3) The non-cash, pretax Special Charge of $957 million includes a writedown of the Company's oil and gas properties and a writeoff of surplus railroad assets. See Note 3 of Notes to Consolidated Financial Statements.

(4) Fourth quarter 1986 includes $32 million, $0.43 per share, reduction to Net Income for investment tax credit which had been reflected in the tax provision in the first three quarters of 1986.

(5) The retroactive application of the new method of depreciation is recognized effective as of January 1, 1986. See Note 2 of Notes to Consolidated Financial Statements. The change in method had the effect of decreasing Net Income for 1985 on a pro forma basis for the first quarter by $9 million, $0.11 per share; second quarter by $9 million, $0.13 per share; third quarter by $9 million, $0.13 per share; and fourth quarter by $13 million, $0.17 per share.

Item Nine

DISAGREEMENTS ON ACCOUNTING AND FINANCIAL DISCLOSURE

None

PART III

Items Ten and Eleven

DIRECTORS AND EXECUTIVE OFFICERS OF THE REGISTRANT AND EXECUTIVE COMPENSATION

A definitive proxy statement of Burlington Northern Inc. will be filed not later than 120 days after the end of the fiscal year with the Securities and Exchange Commission. The information set forth therein under "Election of Directors" and "Executive Compensation" is incorporated herein by reference. Executive Officers of Burlington Northern Inc. and principal subsidiaries are listed on pages 16, 17 and 18 of this Form 10-K.

Item Twelve

SECURITY OWNERSHIP OF CERTAIN BENEFICIAL OWNERS AND MANAGEMENT

Information required is set forth under the caption "Election of Directors" in the Proxy Statement for the 1987 Annual Meeting of Stockholders and is incorporated herein by reference.

Item Thirteen

CERTAIN RELATIONSHIPS AND RELATED TRANSACTIONS

Information required is set forth under the caption "Executive Compensation" in the Proxy Statement for the 1987 Annual Meeting of Stockholders and is incorporated herein by reference.

PART IV

Item Fourteen

EXHIBITS, FINANCIAL STATEMENT SCHEDULES AND REPORTS ON FORM 8-K

Supplemental Financial Statement Schedules

All required schedules will be filed by amendment to this Form 10-K on Form 8.

Exhibit Index

Exhibit Designation	Nature of Exhibit	Page
11	Computation of Earnings per Share	73
22	Subsidiaries of Burlington Northern Inc.	74

Reports on Form 8-K

During the fourth quarter of 1986, there were no Reports filed on Form 8-K.

SIGNATURES REQUIRED FOR FORM 10-K

Pursuant to the requirements of Section 13 or 15(d) of the Securities Exchange Act of 1934, Burlington Northern Inc. has duly caused this report to be signed on its behalf by the undersigned, thereunto duly authorized.

BURLINGTON NORTHERN INC.

By RICHARD M. BRESSLER
Richard M. Bressler
Chairman of the Board, President
and Chief Executive Officer

Pursuant to the requirements of the Securities Exchange Act of 1934, this report has been signed below by the following persons on behalf of Burlington Northern Inc. and in the capacities and on the dates indicated.

By RICHARD M. BRESSLER Richard M. Bressler	Chairman of the Board, President and Chief Executive Officer	January 22, 1987
LUINO DELL'OSSO, JR. Luino Dell'Osso, Jr.	Senior Vice President, Finance & Planning	January 22, 1987
FRANK J. WINNERMARK Frank J. Winnermark	Vice President & Controller, Chief Accounting Officer	January 22, 1987
ROYAL D. ALWORTH, JR. Royal D Alworth, jr.	Director	January 22, 1987
ZANE E. BARNES Zane E. Barnes	Director	January 22, 1987
DANIEL P. DAVISON Daniel P. Davison	Director	January 22, 1987
WALTER A. DREXEL Walter A. Drexel	Director	January 22, 1987
MARY GARST Mary Garst	Director	January 22, 1987
RICHARD C. GRAYSON Richard C. Grayson	Director	January 22, 1987
GERALD GRINSTEIN Gerald Grinstein	Director	January 22, 1987

SECURITIES AND EXCHANGE COMMISSION

Washington, D. C. 20549

FORM 10-K

Annual Report Pursuant to Section 13 or 15(d) of
The Securities Exchange Act of 1934

REGISTRANT MEETS THE CONDITIONS SET FORTH IN GENERAL INSTRUCTION J(1)(a) AND (b) OF FORM 10-K AND IS THEREFORE FILING THIS FORM 10-K WITH THE REDUCED DISCLOSURE FORMAT PERMITTED BY GENERAL INSTRUCTION J.

For the fiscal year ended
December 31, 1986

Commission File Number 1-6324

BURLINGTON NORTHERN RAILROAD COMPANY
(Exact name of registrant as specified in its charter)

Delaware	41-6034000
(State or other jurisdiction of incorporation or organization)	(I.R.S. Employer Identification No.)
3800 Continental Plaza 777 Main Street Fort Worth, Texas	76102
(Address of principal executive offices)	(Zip Code)
Registrant's telephone number, including area code	(612) 298-2795

Securities registered pursuant to Section 12(b) of the Act:

Title of each class	Name of each exchange on which registered
Great Northern Railway Company General Mortgage Bonds: 3 1/8%, Series N, due 1990) 3 1/8%, Series O, due 2000) 2 5/8%, Series Q, due 2010)	New York Stock Exchange
Northern Pacific Railway Company: Prior Lien Railway and Land Grant 4% Bonds, due 1997) General Lien Railway and Land Grant 3% Bonds, due 2047)	New York Stock Exchange
Chicago, Burlington & Quincy Railroad Company First & Refunding Mortgage Bonds, 3%, due 1990)	New York Stock Exchange