Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of the Application of HUGHES COMMUNICATIONS GALAXY, INC. and SATELLITE TRANSPONDER LEASING CORPORATION For Authority to Construct and Launch One Hybrid Domestic Communications Satellite, Galaxy VII(H), to Operate in Both the C and Ku Bands to Serve as a Replacement for the SBS-4 Satellite and as a Substitute for the Galaxy VI Satellite	File No. 20 DSS-P/LA-90

APPLICATION

Hughes Communications Galaxy, Inc. ("HCG") and, to the extent set forth below, Satellite Transponder Leasing Corporation ("STLC") hereby apply for authority to construct, launch, and operate a hybrid domestic fixed communications satellite to be known as Galaxy VII(H), which will operate in both the C and Ku bands. At Ku band, Galaxy VII(H) will be a replacement for STLC's current SBS-4 satellite.[1/] At C band, Galaxy VII(H) will be a substitute for HCG's Galaxy VI satellite (formerly Westar VI-S). This Application, therefore, constitutes (1) an application supported jointly by STLC and HCG for a replacement satellite for SBS-4 and (2) a request by HCG alone to modify its authorization for Galaxy VI.

As explained more fully below, HCG's and STLC's plans to locate a single hybrid satellite at 91° W.L. are a response

1. As explained more fully below, pending before the Commission is an application for consent to transfer control of STLC to HCG.

to customer demands. The proposed hybrid design, which affords substantial savings compared to operating two single-band satellites at that location, will employ full frequency re-use at both C and Ku band, while maintaining levels of power that are now standard on single-band satellites.

The grant of authorization to construct, launch and operate this hybrid satellite does not require the assignment of any new orbit locations. The request at Ku band is merely for replacement of an existing in-orbit satellite, SBS-4, at its current orbital assignment; at C band, the request seeks no more than substitution of an authorized single-band satellite, Galaxy VI, by a more advanced hybrid at the same location. As explained more fully below, Galaxy VI, after its substitution, will be deployed for another use not requiring an additional orbital assignment. Thus, this Application can be processed expeditiously, without the need for simultaneous consideration of applications seeking new orbital assignments.

ITEM C. System Description

(a) Satellite Systems of HCG and STLC

(i) STLC.

STLC is the licensee of the domestic fixed Ku band satellites known as SBS-4, SBS-5, and SBS-6. SBS-4, which operates at the 91° W.L. location, and SBS-5, which operates at 123° W.L., are used primarily to provide data, voice and video communications to thousands of very small aperture terminals ("VSATs") used by firms in the retail, financial, medical and travel industries. SBS-6, which is scheduled to be launched in

June, 1990, has been assigned to the 72° W.L. location, but STLC and HCG have requested an interim assignment of 99° for that satellite.[2]

IBM, HCG, and STLC have filed an application for Commission consent to transfer control of STLC from IBM to HCG.[3] Upon the consummation of that transaction, HCG will control SBS-4, SBS-5, and SBS-6, and those satellites will become part of HCG's domestic satellite system described below. Upon Commission consent, after the proposed transfer of control of STLC, the Ku band payload of Galaxy VII(H) will replace SBS-4 in the fashion described in this Application. HCG's financial qualifications are established in Item J below.

If the proposed transfer of control of STLC is approved and consummated, HCG would like to be in a position to incorporate SBS-4's replacement into a satellite that can be launched by December, 1992. Accordingly, the present application is being filed now, contingent upon consummation of the transfer of control.[4] HCG and STLC request that, consistent with this contingency, this Application be processed expeditiously.

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2. File No. 1841-DSS-MISC-89 (filed July 21, 1989).

3. File Nos. 1838-DSS-TC-89, 1839-DSS-TC-89, 1840-DSS-TC-89 (filed July 21, 1989).

4. STLC has joined in this application as an "accommodation" to HCG, pending the transfer of control of STLC. See, e.g., Hughes Communications Galaxy, 3 FCC Rcd 6989, ¶ 11 (1988)(granting to HCG replacement authorizations for Westar IV and V); Western Union Corporation and Hughes Communications Galaxy, 3 FCC Rcd 6792, 6794 n.3 (1988).

(ii) HCG

HCG is the licensee of the Galaxy and Westar systems of domestic fixed communications satellites. This fleet includes six C band satellites: Galaxy I, Galaxy II, Galaxy III, Westar IV, Westar V and Westar III (which has recently been retired). HCG has been authorized to construct, launch and operate replacements for each of those satellites.[5/] In addition, HCG has been authorized to construct one expansion C band satellite (recently re-assigned to the 81° location)[6/] and two Ku band satellites (assigned to 99° and 131°).[7/] HCG's C band satellites are primarily used to provide distribution of programming for the cable and broadcast (both television and radio) industries.

HCG and STLC expect to make the transponders on Galaxy VII(H) available primarily through sales and non-common carrier leases, pursuant to the Commission's decision in Domestic Fixed-Satellite Transponder Sales, 90 F.C.C.2d 1238 (1982). Depending upon the needs and desires of customers, common carrier operations could also be possible, but such operations would likely be undertaken through transponder sales to HCG's

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5. These replacement satellites are known as Galaxy I-R, Galaxy II-R, Galaxy III-R, Galaxy IV-R (formerly Westar IV-R), Galaxy V-W (formerly Westar V-R), and Galaxy VI (formerly Westar VI-S), respectively.

6. This satellite is known as Galaxy V-E.

7. These Ku band satellites are now known as Galaxy A-R and Galaxy B-R, respectively. On October 3, 1989, HCG filed an application to consolidate its authorizations for Galaxy A-R and Galaxy IV-R into one hybrid satellite, Galaxy IV(H), File Nos. 1-DSS-MP/ML-89, 2-DSS-MP/ML-89 and 3-DSS-ML-89.

licensed common carrier affiliate, Hughes Communications Carrier Services, Inc. ("HCCS"), which would in turn provide the common carrier services.

In general, customers will provide their own uplink to Galaxy VII(H). HCG, however, has uplink capability available for its customers through a geographically diverse network of earth stations in several metropolitan areas operated by its affiliate, Hughes Communications Satellite Service, Inc. ("HCSS).

HCG employs a sophisticated network of earth stations to perform the necessary telemetry, tracking, and command ("TT&C") functions. HCSS owns and operates the Operations Control Center ("OCC") in El Segundo, California (near Los Angeles) where the complex coordination and integration of the space and terrestrial segments of the HCG network are focused. The OCC directs the launch through in-orbit activities of all HCG spacecraft and performs subsystem testing and stationkeeping functions once the satellites are in their respective geostationary positions 22,300 miles above the earth. The OCC has been designed and staffed to allow improved stationkeeping of ±0.5° in order to enhance communications performance under the Commission's two-degree spacing policy.

Telemetry data from the satellites is received by TT&C earth stations in Spring Creek (Brooklyn), New York and Fillmore, California. This data is then transmitted to the OCC where it is processed, archived, and analyzed. Commands to control the spacecraft are issued from the OCC and subsequently routed to the TT&C earth stations for processing and uplinking to the satellites. Although the earth stations are under the overall control of the OCC, each station may operate independently of the OCC, if necessary.

The Galaxy Network Operations Center immediately adjacent to the OCC, monitors the transmissions from HCG's satellites using receive-only antennas on the roof of the building. Staff personnel assist users in resolving interference problems and when transmissions to the satellites are initiated.

(b) Replacement Expectancy for SBS-4

The Commission has already found that a form of replacement expectancy in the domestic satellite industry is in the public interest. The Commission has concluded that

> in the capital-intensive domestic satellite industry, there should be some assurance that operators will be able to continue to serve their customers. To do otherwise would chill investment and would impose large costs on satellite users.

Domestic Fixed-Satellite Services, 58 Rad. Reg. 2d (P&F) 1267, ¶27 (1985). As the Commission stated in enunciating the rationale for the renewal expectancy of a broadcast licensee, "Licensees should be encouraged through the likelihood of renewal to make investments to ensure quality service." Cowles Broadcasting, 86 F.C.C.2d 993, 1013 (1981). That reasoning applies even more strongly in the domestic satellite industry, where the magnitude and risk of capital investment is far greater than in the broadcast industry.

In applying that policy, the Commission has routinely processed and granted requests by satellite operators for replacement authority. As the Commission ruled in granting to HCG replacement authorizations for Galaxy I, II and III:

> Action here is consistent with our traditional policy to grant routinely uncontested applications for replacement satellites at the same location as retired satellites, as well as with our goal to provide continuity of service to both the operators and their customers.

Hughes Communications Galaxy, 3 FCC Rcd 6989, ¶ 10 (1988).[8]

The grant of authorization to replace SBS-4 is further supported by the need and legitimate expectation of STLC's long-time customers. Customers on SBS-4 currently have, in the aggregate, tens of thousands of VSAT antennas pointed at that satellite. The failure to replace SBS-4 would result in the costly requirement of repointing those earth stations at alternative satellites. As the Commission is well aware, this repointing effort could result in a prolonged period in which certain earth station networks would be made temporarily inoperative, and would in any case have severely adverse effects on the VSAT industry. See generally GE American Communications, 3 FCC Rcd 6871 (1988).

If this replacement application is granted in a timely fashion, Galaxy VII(H) will be able to provide continuous

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8. The Commission recently has granted replacement authority to a number of other satellite operators. See Alascom, 3 FCC Rcd 6978 (1988); American Telephone and Telegraph Company, 3 FCC Rcd 6980 (1988); Contel ASC, 3 FCC Rcd 6982 (1988); GTE Spacenet Corporation, 3 FCC Rcd 6986 (1988); GE American Communications, 4 FCC Rcd 6534 (1989).

uninterrupted coverage to the users of SBS-4. Galaxy VII(H) will be scheduled for launch at as early a date as practicable, in order to minimize any risk of a lapse in Ku band coverage at the 91° location and in order to provide enhanced Ku band service to 91° as soon as possible.[9] Galaxy VII(H) provides a full 1000 MHz of Ku band capacity with 50 watt transmitters, in contrast to the 500 MHz of capacity with 20 watt transmitters of SBS-4. These benefits, together with cross strapping and other features of modern hybrid technology described below, should be brought to the public as soon as possible.

(c) Substitution of Galaxy VI and Hybrid Benefits

In June 1990, HCG plans to launch Galaxy VI (formerly Westar VI-S) into the 91° location as the authorized replacement for Westar III to provide successor C band capacity at that location. If the Commission approves the transfer of control of STLC, HCG will be operating two separate single-band satellites at the 91° location. This situation at the 91° W.L. location presents HCG with an opportunity to take advantage of recently developed hybrid satellite technology.

HCG's customers have begun to require services that can best be provided either more efficiently or in some cases uniquely by hybrid satellites. For example, some customers now require cross-strapping in order to be able to coordinate Ku band backhauls with C band distribution on the same satellite. Only recently, however, has Hughes Aircraft Company developed

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9. HCG currently plans to launch Galaxy VII(H) in November 1992, well in advance of the expected end of life of SBS-4 in 1994.

technology that enables its C and Ku band payloads to be located on the same satellite without sacrificing full frequency re-use at both bands and without reducing the power levels commonly used on single-band satellites.[10] By applying this new hybrid technology at the 91° W.L. location, HCG will be better able to meet its customers' demands into the twenty-first century.

As mentioned above, Galaxy VI is scheduled to be launched into the 91° location in June 1990 as a replacement for Westar III. Galaxy VI is intended to serve as back up for the entire Galaxy C band system. Satellite customers, especially cable programmers, now demand the safety net of back-up in-orbit capacity. Galaxy VI is designed to meet that need. As part of this plan, HCG recently filed an application, File No. 13-DSS-ML-90, to have Galaxy VI reassigned in late 1991 to the 99° location on an interim basis in order to provide continuous coverage at that location from the time that HCG's existing Westar IV satellite reaches end-of-life until its proposed Galaxy IV(H) hybrid satellite becomes operational (expected to occur in mid-1993).[11] However, HCG also desires

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10. In fact, the Galaxy VII C band payload, with its sixteen-watt transponders, will offer even better performance than Galaxy VI with its ten-watt transponder design.

11. Although Galaxy VI's departure from the 91° location will mean a brief temporary lack of C band capacity at that site, its absence will not have unexpected or adverse consequences to the user community, because, as a crucial adjunct to its role as a backup for the entire system, HCG intends to sell Galaxy VI capacity on a preemptible basis only.

to have permanent C band capacity at 91° at as early a date as possible. By substituting the C band payload of the Galaxy VII(H) hybrid for Galaxy VI, HCG will be able to provide users with permanent C band capacity at the 91° location commencing in December 1992 rather than awaiting Galaxy VI's return in 1993.

In addition to fulfilling customer demands, the construction of the hybrid Galaxy VII(H) satellite will also result in cost efficiencies, which ultimately benefit the public. The proposed hybrid design results in significant cost savings compared with the launch of two separate single-band satellites.

HCG recognizes that, assuming the launch schedules proposed in this and in the Galaxy IV(H) applications, provision must be made for a new Galaxy VI orbital assignment sometime in 1993.[12/] Galaxy VI will continue to serve its essential role as a back-up for the entire Galaxy satellite fleet, no matter where it is assigned. One potential orbital location for Galaxy VI in 1993 is 72°, where it could serve as a replacement for HCG's Galaxy II satellite, whose end of life

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12. Galaxy VI will be launched into its assigned location of 91° in June 1990. It will be relocated to 99° in late 1991 to ensure C band capacity at that location until the launch of Galaxy IV(H) in mid-1993. Thus, assuming Galaxy VII(H) is launched in late 1992, Galaxy VI will not be able to return to the 91° location.

coincides with Galaxy VI's availability.[13] Alternatively, HCG may seek an additional orbital assignment for Galaxy VI (which in all likelihood will result in a new processing round). In any event, HCG recognizes that a post-1993 orbital location for Galaxy VI is subject to further Commission action and that HCG is proceeding at its own risk with respect to the post-1993 operation of Galaxy VI.

(d) Relationship to Processing Rounds

HCG and STLC respectfully submit that this Application to construct, launch, and operate Galaxy VII(H) should be acted upon by the Commission independently of any future group of satellite applications. With respect to the replacement of SBS-4, HCG and STLC note that the Commission has never articulated any policy requiring applications for replacement satellites to be treated as part of regular processing rounds. To the contrary, virtually every participant in the FCC's various satellite proceedings to comment on the issue recently has expressed the view that replacement applications should be considered outside the FCC's processing rounds. See, e.g., Comments of GTE, DS-684 (Jan. 19, 1988) at 30; Reply Comments of Contel ASC, DS-684 (Feb. 23, 1988) at 5-6. Consideration of replacement applications separately is sound public policy because it supports the Commission's goal of continuity of

13. HCG already has been granted authority to replace Galaxy II. See Hughes Communications Galaxy, 3 FCC Rcd 6789 (1988). HCG acknowledges that the use of Galaxy VI as the replacement for Galaxy II would require a modification of HCG's existing authority to replace Galaxy II.

service, as articulated in the Two-Degree Spacing Order, 54 Rad. Reg. 2d (P&F) 577 (1983).

With respect to the substitution of Galaxy VI, HCG submits that the request to modify the authorization of Galaxy VI is the type of modification that is invariably processed separately from applications for satellites at new orbit locations. This request neither changes the allocated frequency band in which Galaxy VI has been authorized to operate, nor requires the assignment of an additional orbit location to HCG, nor even changes any of HCG's existing orbital assignments.[14/]

Most broadly, the location of a hybrid Galaxy VII(H) satellite at 91° W.L. will not require the assignment of any new orbital location to HCG. As indicated above, upon the transfer of control of STLC, HCG will be authorized to operate in both the C and Ku bands at the 91° W.L. location. At Ku band, Galaxy VII(H) will function as the replacement for SBS-4. At C band, Galaxy VII(H) will function as a substitute satellite for Galaxy VI. Galaxy VI in turn will be used as a replacement for another expiring HCG satellite, so that no new assignment will be required for it.[15/] The authorization of

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14. Cf. Two-Degree Spacing Order, 54 Rad. Reg. 2d (P&F) 577, 608-09 (1983)(discussing certain applications that are not to be considered as part of a processing round).

15. Alternatively, Galaxy VI could replace a failed satellite. In any event, no new orbital location would be required. If HCG were to seek an additional location for Galaxy VI, it would have to file a formal application with the Commission, which would trigger a new processing round. See Public

Galaxy VII(H) therefore will not affect the ability of other satellite operators to obtain additional orbit locations, so there is no reason to consider it as part of a processing round.

ITEM D. General Technical Information

1. Satellite Operational Characteristics

a. Frequency Plan

Galaxy VII(H) will be constructed to operate in the C and Ku bands. The radio frequency and polarization plans are shown in Figures 1a and 1b; center frequency and polarization assignments are listed in Tables 1a and 1b.

The C band communications payload consists of 24 active transponder channels, each with a bandwidth of 36 MHz. The Ku band communications payload contains 24 active transponder channels, consisting of eight wideband (54 MHz bandwidth) channels and 16 narrowband (27 MHz bandwidth) channels.

Certain channels within the communications payload are equipped with "cross-strap" switches. These ground-controlled switches allow specific C band uplink channels to be retransmitted through Ku band downlink channels and, conversely, allow specific Ku band uplink channels to be retransmitted through C band downlink channels. The channels equipped with cross-strapping capabilities are listed in Table 2.

Notice, Report No. DS-635 (June 10, 1987) (request for a new orbit location for GSTAR IV triggered initiation of new processing round).

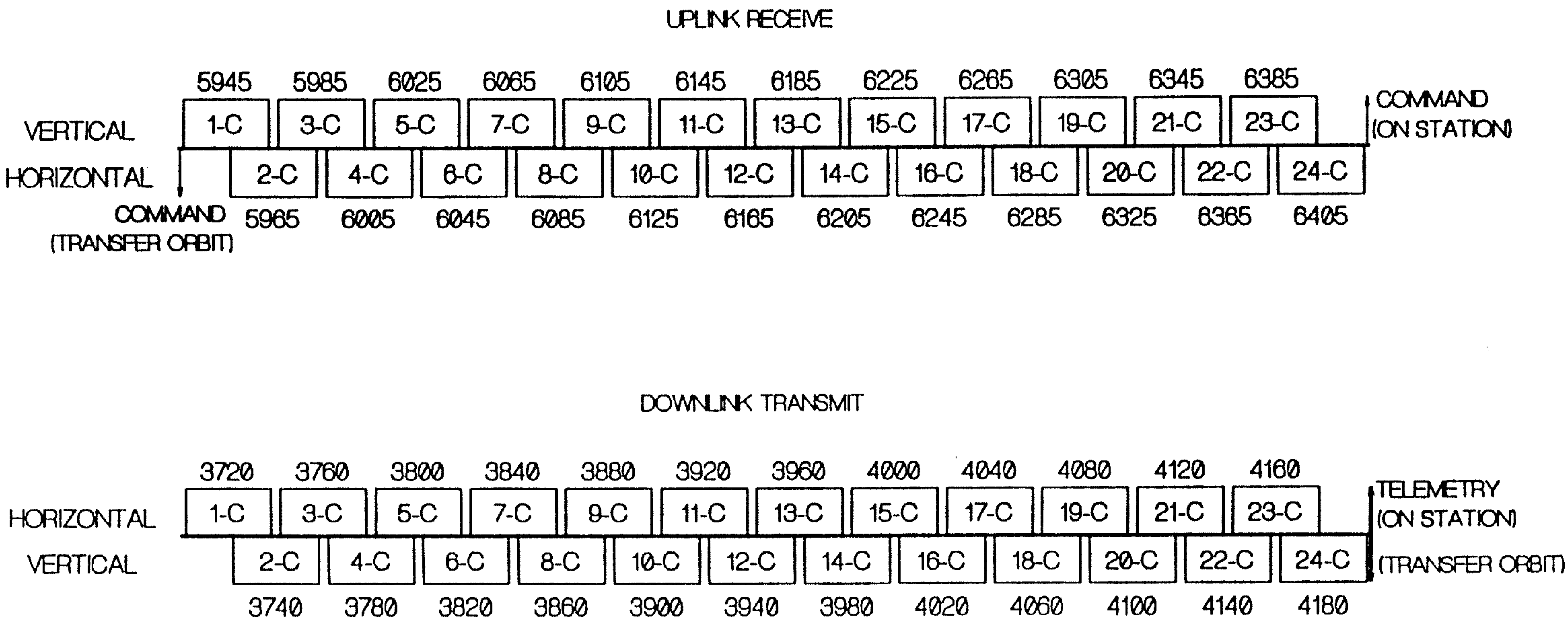

FIGURE 1a. C-Band FREQUENCY AND POLARIZATION PLAN

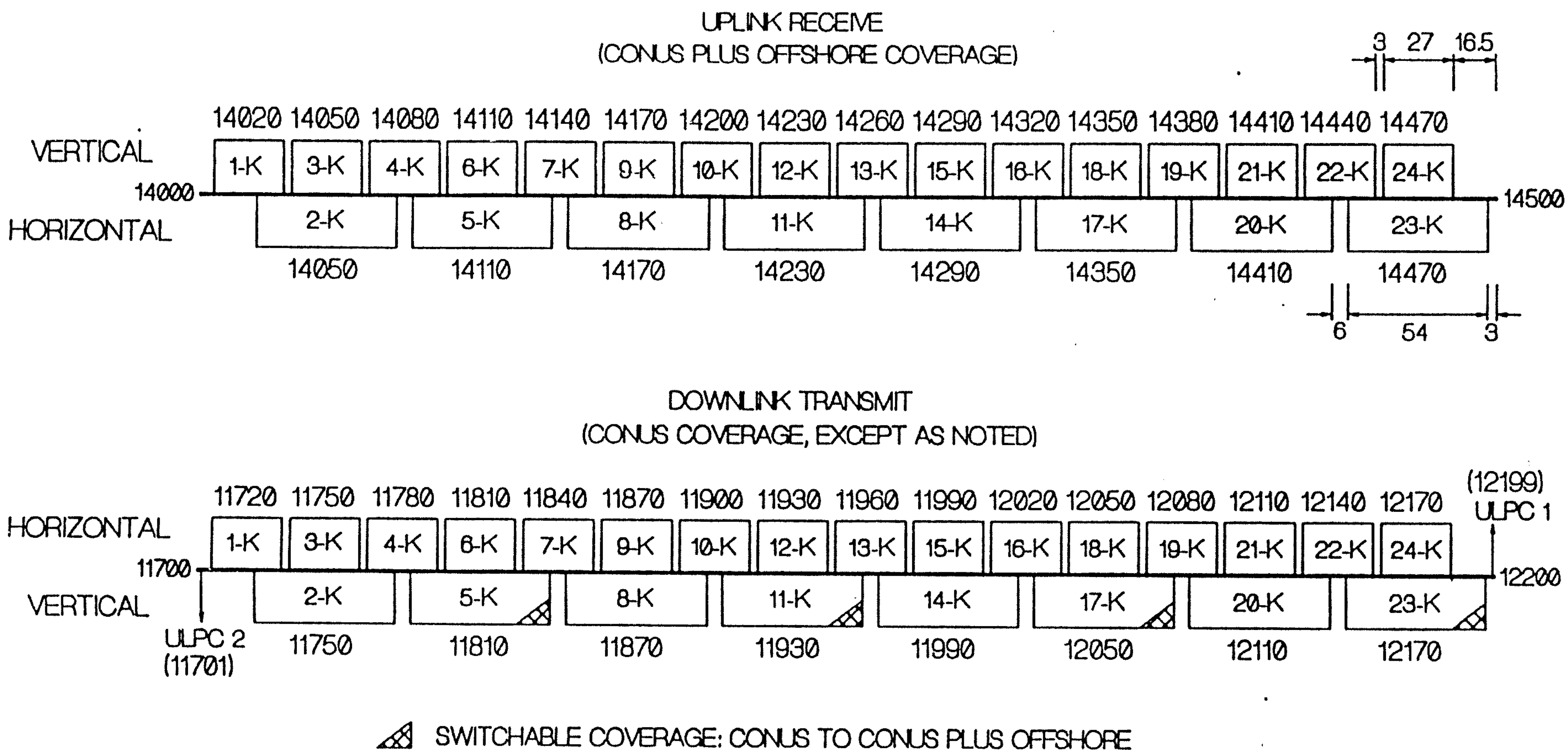

FIGURE 1b. Ku-BAND FREQUENCY AND POLARIZATION PLAN

TABLE 1a

C BAND FREQUENCY AND POLARIZATION ASSIGNMENTS

Channel	Uplink Polarization	Uplink Center Frequency (MHz)	Downlink Polarization	Downlink Center Frequency (MHz)	Transponder Bandwidth (MHz)
1	V	5945	H	3720	36
2	H	5965	V	3740	36
3	V	5985	H	3760	36
4	H	6005	V	3780	36
5	V	6025	H	3800	36
6	H	6045	V	3820	36
7	V	6065	H	3840	36
8	H	6085	V	3860	36
9	V	6105	H	3880	36
10	H	6125	V	3900	36
11	V	6145	H	3920	36
12	H	6165	V	3940	36
13	V	6185	H	3960	36
14	H	6205	V	3980	36
15	V	6225	H	4000	36
16	H	6245	V	4020	36
17	V	6265	H	4040	36
18	H	6285	V	4060	36
19	V	6305	H	4080	36
20	H	6325	V	4100	36
21	V	6345	H	4120	36
22	H	6365	V	4140	36
23	V	6385	H	4160	36
24	H	6405	V	4180	36

V = Vertical polarization
H = Horizontal polarization

TABLE 1b

KU BAND FREQUENCY AND POLARIZATION ASSIGNMENTS

Channel	Uplink Polarization	Uplink Center Frequency (MHz)	Downlink Polarization	Downlink Center Frequency (MHz)	Transponder Bandwidth (MHz)
1	V	14020	H	11720	27
2	H	14050	V	11750	54
3	V	14050	H	11750	27
4	V	14080	H	11780	27
5	H	14110	V	11810	54
6	V	14110	H	11810	27
7	V	14140	H	11840	27
8	H	14170	V	11870	54
9	V	14170	H	11870	27
10	V	14200	H	11900	27
11	H	14230	V	11930	54
12	V	14230	H	11930	27
13	V	14260	H	11960	27
14	H	14290	V	11990	54
15	V	14290	H	11990	27
16	V	14320	H	12020	27
17	H	14350	V	12050	54
18	V	14350	H	12050	27
19	V	14380	H	12080	27
20	H	14410	V	12110	54
21	V	14410	H	12110	27
22	V	14440	H	12140	27
23	H	14470	V	12170	54
24	V	14470	H	12170	27

V = Vertical polarization
H = Horizontal polarization

TABLE 2

FREQUENCY CROSS-STRAP CHANNELS

Uplink Channel	Downlink Channel Options*
18-C	18-C , 17-K
24-C	24-C , 23-K
17-K	17-K , 18-C
23-K	23-K , 24-C

* Selectable by ground command

In addition to the communications channel frequencies, two C band command uplink, two C band telemetry downlink, and two Ku band downlink beacon frequencies are shown in the plan. During transfer orbit, command signals will be received through a bicone antenna at the higher band-edge of the C band uplink frequencies. When the satellite is at final orbit position, the primary command uplink will be received at the lower band-edge of the C band frequencies through the large C band communications reflector, with the bicone link available as a backup. The command uplink will use government-approved command encryption. The two C band telemetry frequencies shown in the plan will allow simultaneous transmission of two separate or redundant telemetry data streams. The vertically and horizontally polarized Ku band downlink beacon signals will be continuously transmitted by the satellite and used by earth station operators as a calibrated reference to compensate for rain attenuation and to adjust antenna pointing.

The satellite communication subsystem will include appropriate filtering at the inputs and outputs of the satellite to minimize internal interchannel interference, noise effects outside the satellite frequency band, and out-of-band spurious transmissions.

b. Emission Designators

Commands to the satellite from the TT&C station will be angle-modulated with a large deviation on the uplink carrier. The satellite will be equipped with government-approved command encryption equipment in order to secure command transmissions. Telemetry data from the satellite will be angle-modulated on the downlink carrier. The emission designators for the communications, TT&C and downlink beacon signals are as follows:

Signal	Emission Designator
Command	300KF9DXX
Telemetry/Ranging	120KF9DXX
Downlink Beacon	25KONON
Single Carrier TV	24M0F3FNN
Dual Carrier TV	23M3F8FNF
High Speed Data	25M7G1WDN
Digital (T1) Data	1M17G1WDF
Digital Voice	24K3G1WDF
Digital (64 kbps) Data	48K6G1WDF
FM Audio (Narrowband)	50K0F3EJF
FM Audio (Wideband)	150KF3EJF

c. Communications Coverage

The receive and transmit patterns of the C band antenna provide shaped beam coverage of the contiguous United States ("CONUS"), Alaska, Hawaii, Puerto Rico, and U.S. Virgin Islands. Representative C band receive gain-to-noise temperature ratio ("G/T") and Effective Isotropic Radiated Power ("EIRP") contours are shown in Figures 2a through 2d. Values for Saturation Flux Density ("SFD") for C band communications may be calculated by using the equations specified at the top of Figures 2a and 2b.

The receive pattern for Ku band communications provides coverage over CONUS, Alaska, Hawaii, Puerto Rico and the U.S. Virgin Islands. The Ku band transmit pattern provides CONUS coverage for all Ku band downlinks. In addition, the transmit beams of four specific Ku band channels can be switched into "Offshore" mode. In Offshore mode, CONUS coverage is expanded to include Alaska, Hawaii, Puerto Rico and the U.S. Virgin Islands. Representative Ku band G/T and EIRP contours are shown in Figures 3a through 3e. Satellite SFD may be calculated for Ku band communications by using the equations specified at the top of Figures 3a and 3b.

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PEAK G/T = 3.42 DB/K, SFD = -(G/T + 86.5) (@ 4DB COMMANDABLE STEP ATTEN)

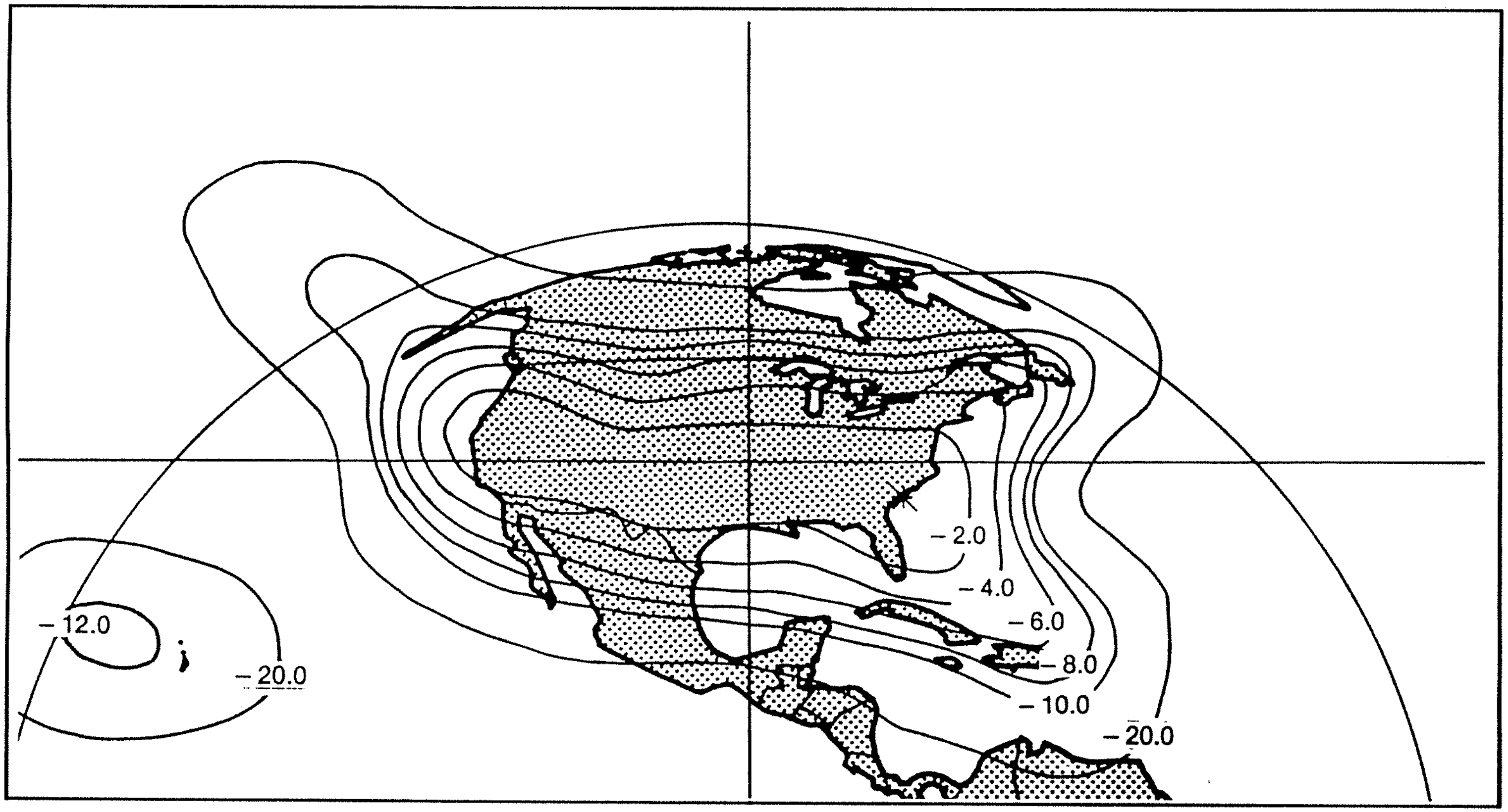

FIGURE 2a. C-BAND G/T COVERAGE AT 91° W.L. (HORIZONTAL RECEIVE)

PEAK G/T = 2.32 DB/K, SFD = -(G/T + 86.5) (@ 4DB COMMANDABLE STEP ATTEN)

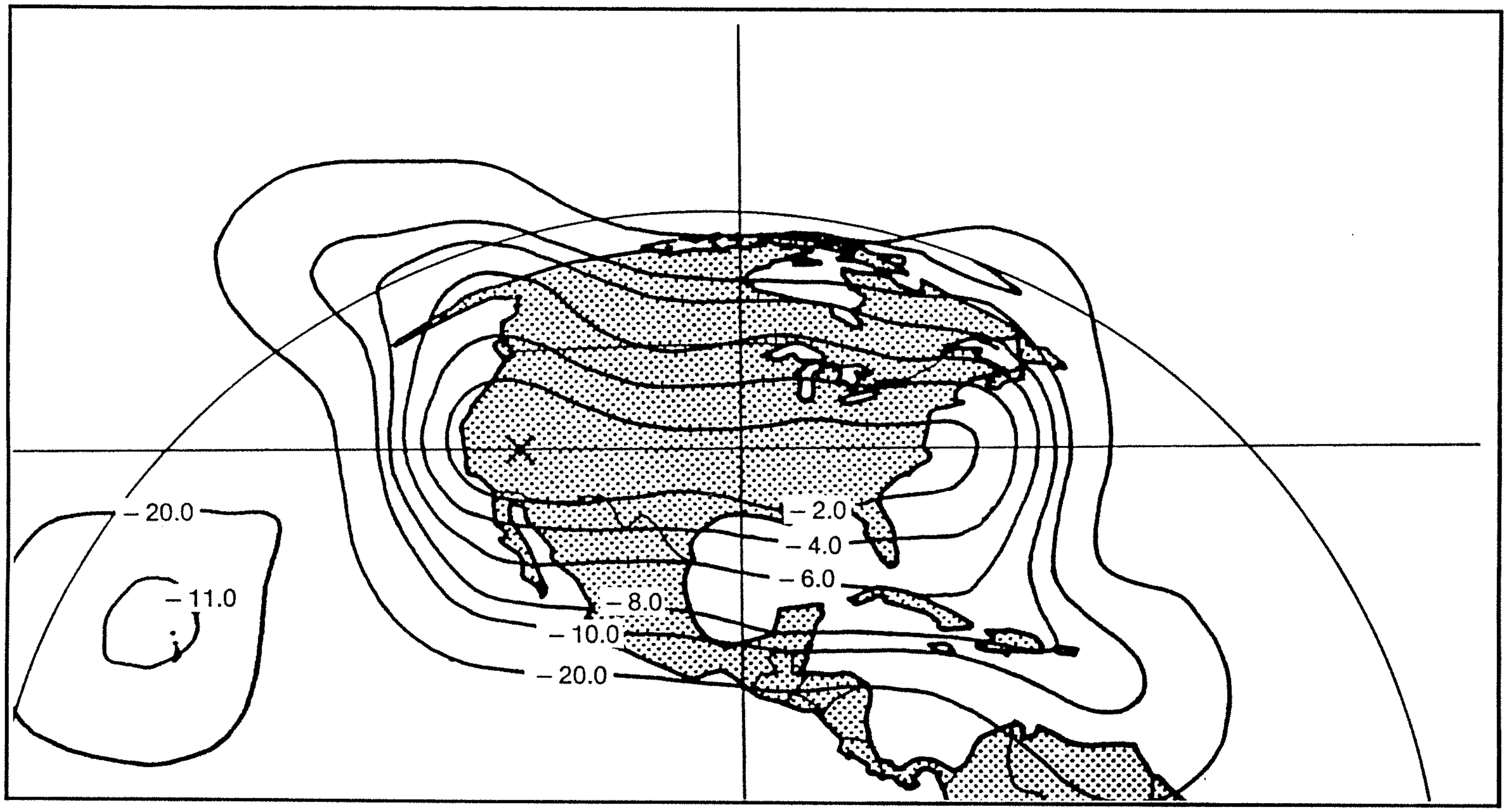

FIGURE 2b. C-BAND G/T COVERAGE AT 91° W.L. (VERTICAL RECEIVE)

PEAK EIRP = 40.8 DBW

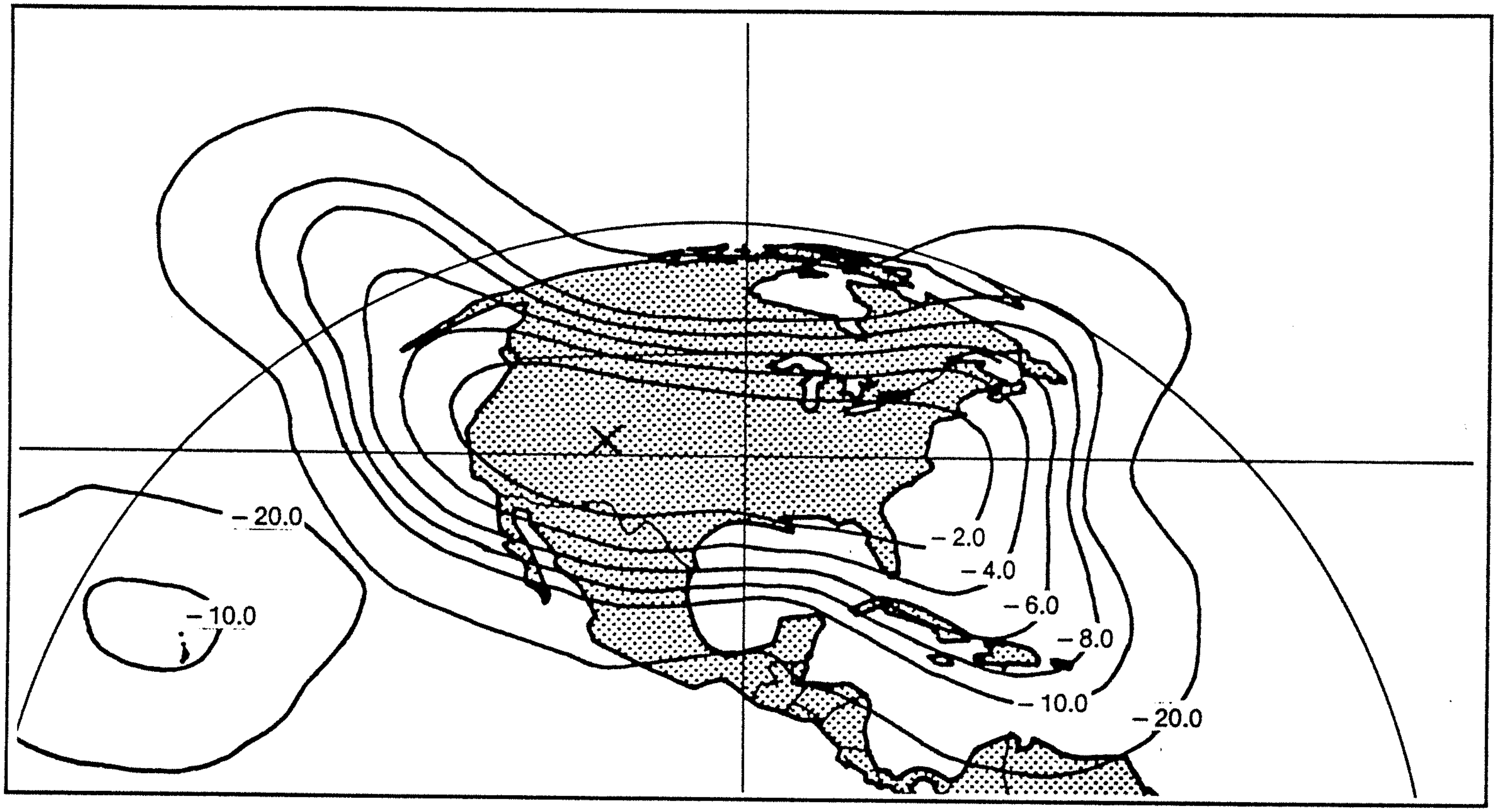

FIGURE 2c. C-BAND EIRP COVERAGE AT 91° W.L. (HORIZONTAL TRANSMIT)

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PEAK EIRP = 40.6 DBW

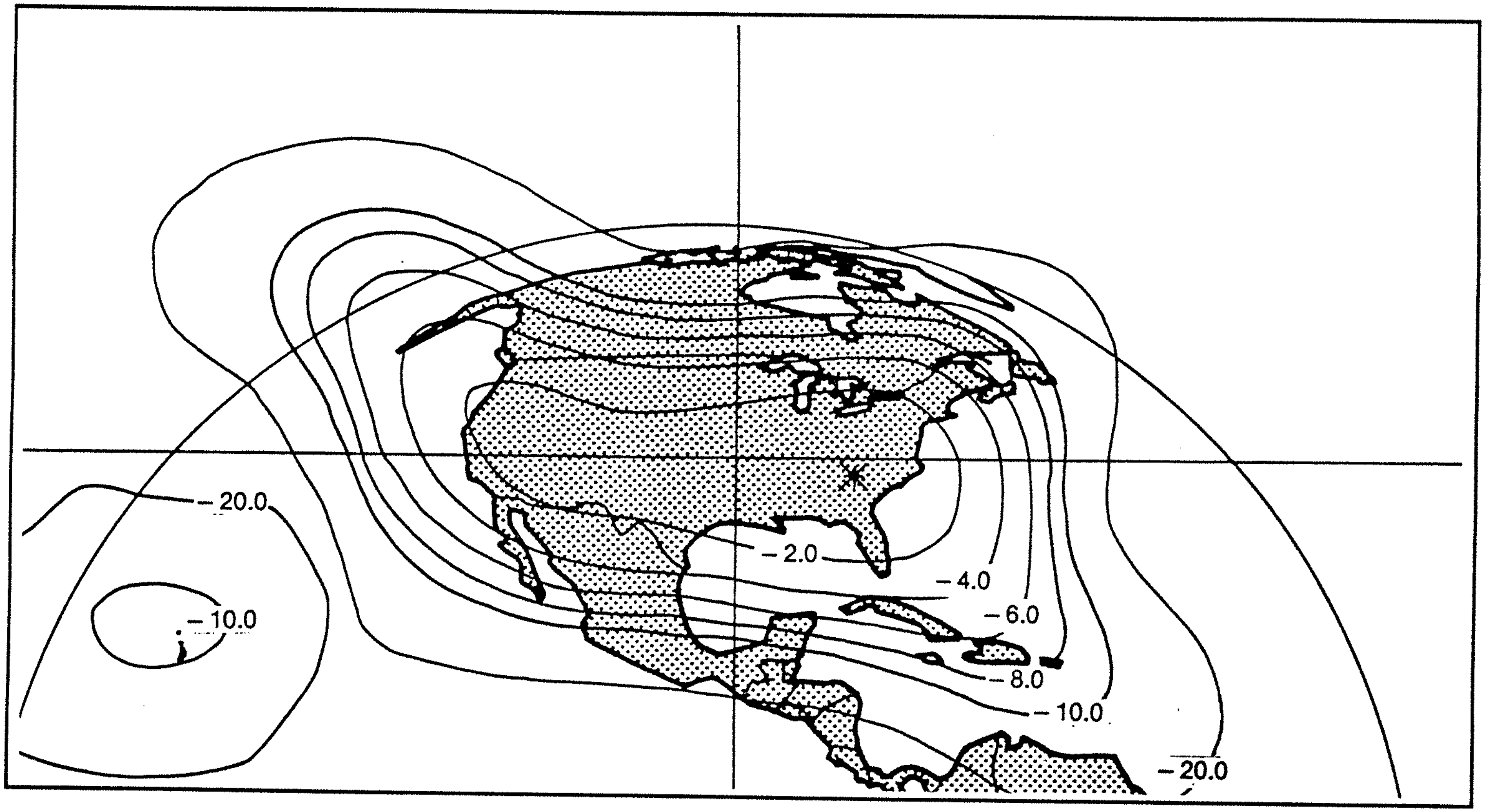

FIGURE 2d. C-BAND EIRP COVERAGE AT 91° W.L. (VERTICAL TRANSMIT)

HUGHES COMMUNICATIONS

PEAK G/T = 5.8 DB/K, SFD = -(G/T + 89.5) (@ 4DB COMMANDABLE STEP ATTEN)

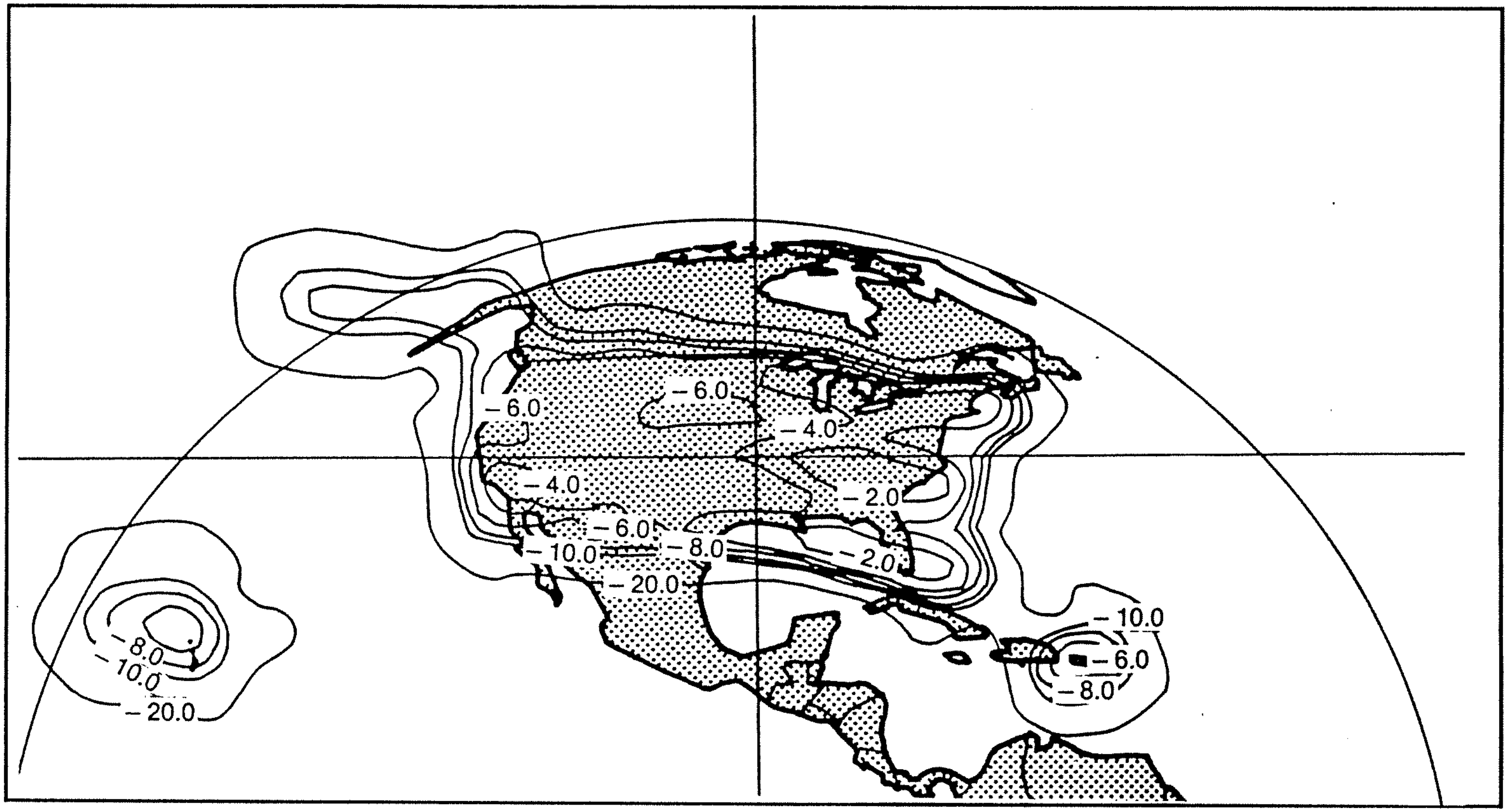

FIGURE 3a. Ku-BAND G/T COVERAGE AT 91° W.L. (HORIZONTAL RECEIVE)

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PEAK G/T = 4.5 DB/K, SFD = -(G/T + 89.5) (@ 4DB COMMANDABLE STEP ATTEN)

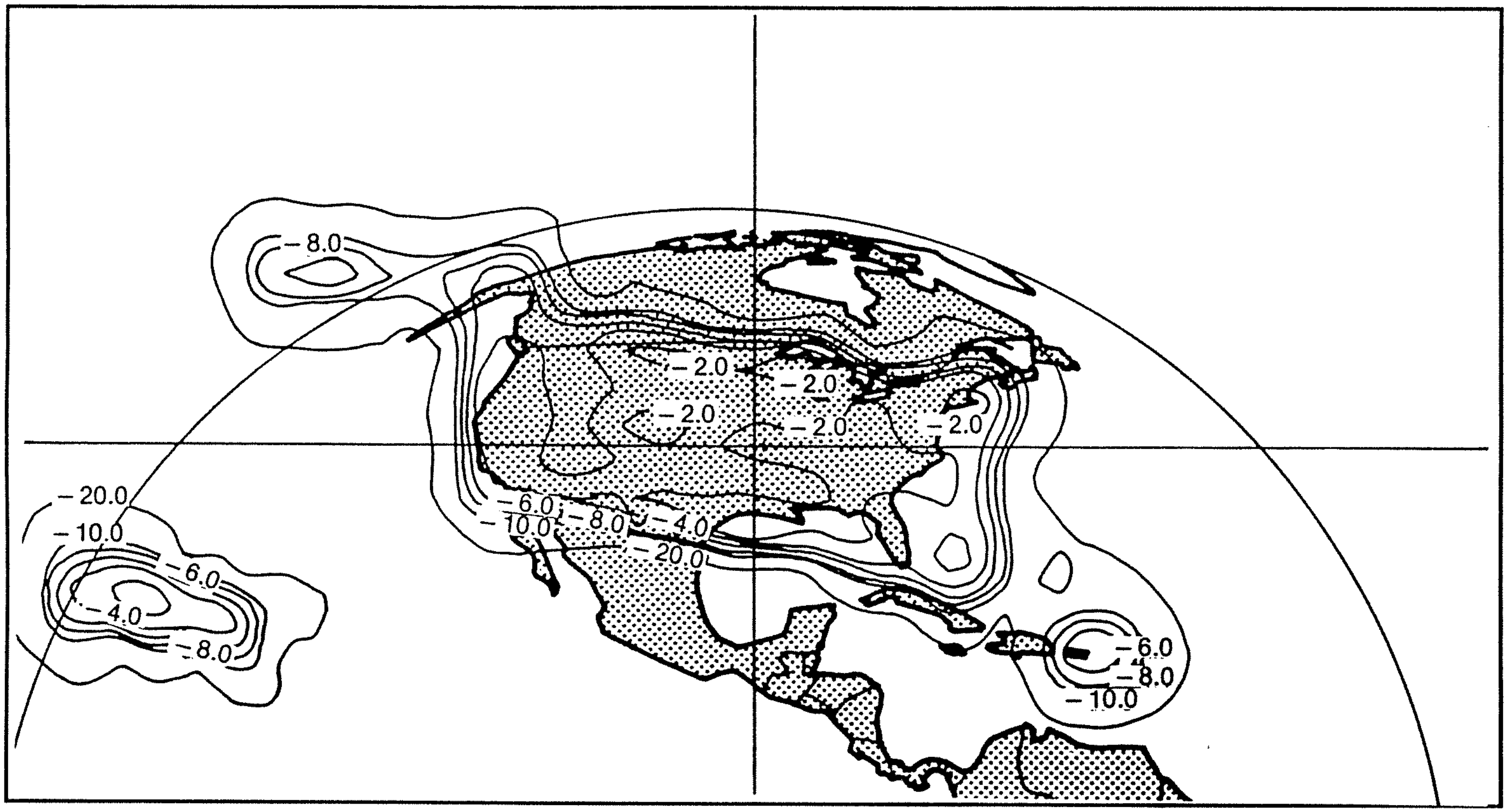

FIGURE 3b. Ku-BAND G/T COVERAGE AT 91° W.L.
(VERTICAL RECEIVE)

HUGHES COMMUNICATIONS

PEAK EIRP = 48.7 DBW

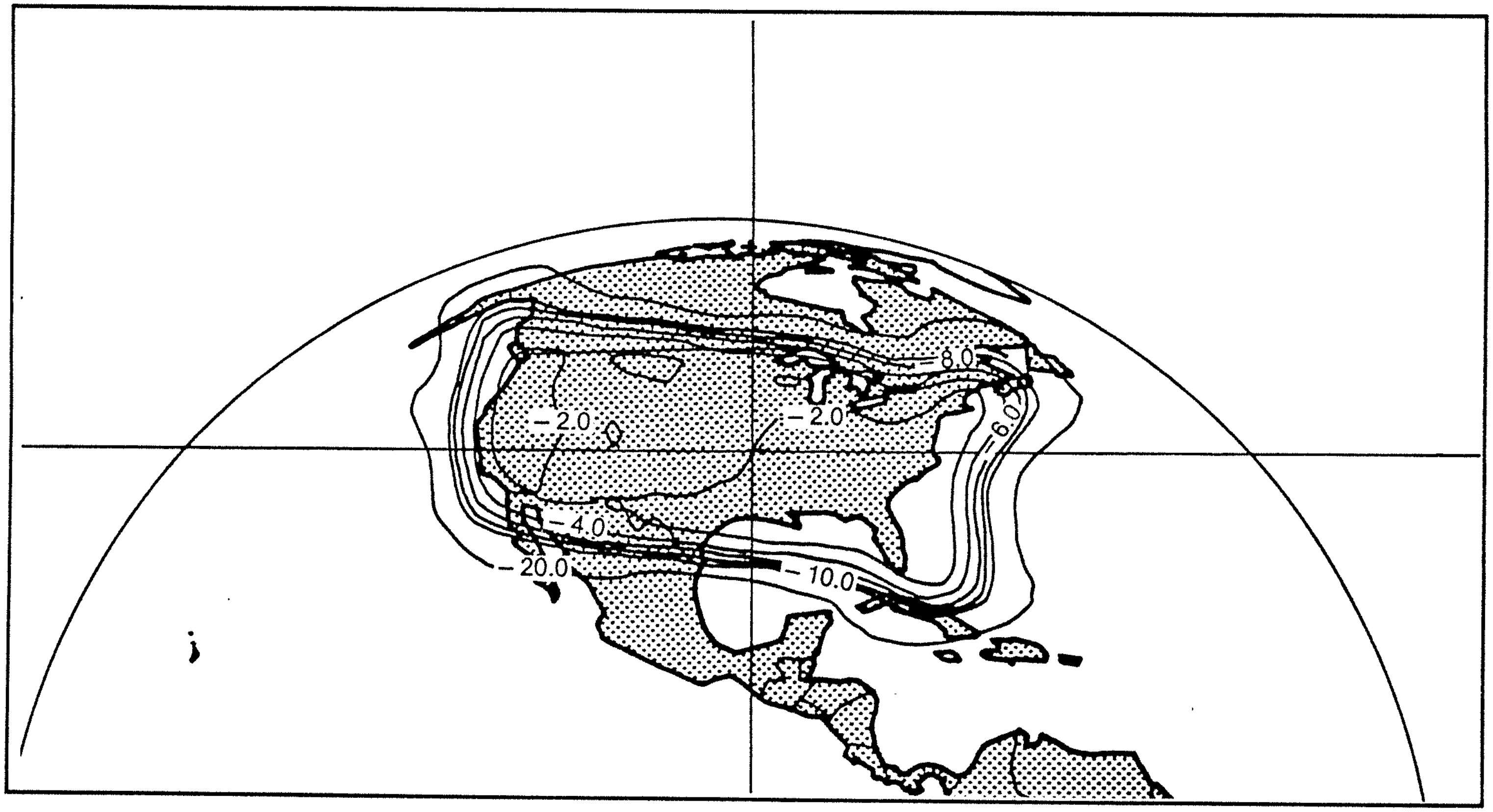

FIGURE 3c. Ku-BAND EIRP COVERAGE AT 91° W.L. (HORIZONTAL TRANSMIT)

HUGHES
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PEAK EIRP = 48.3 DBW

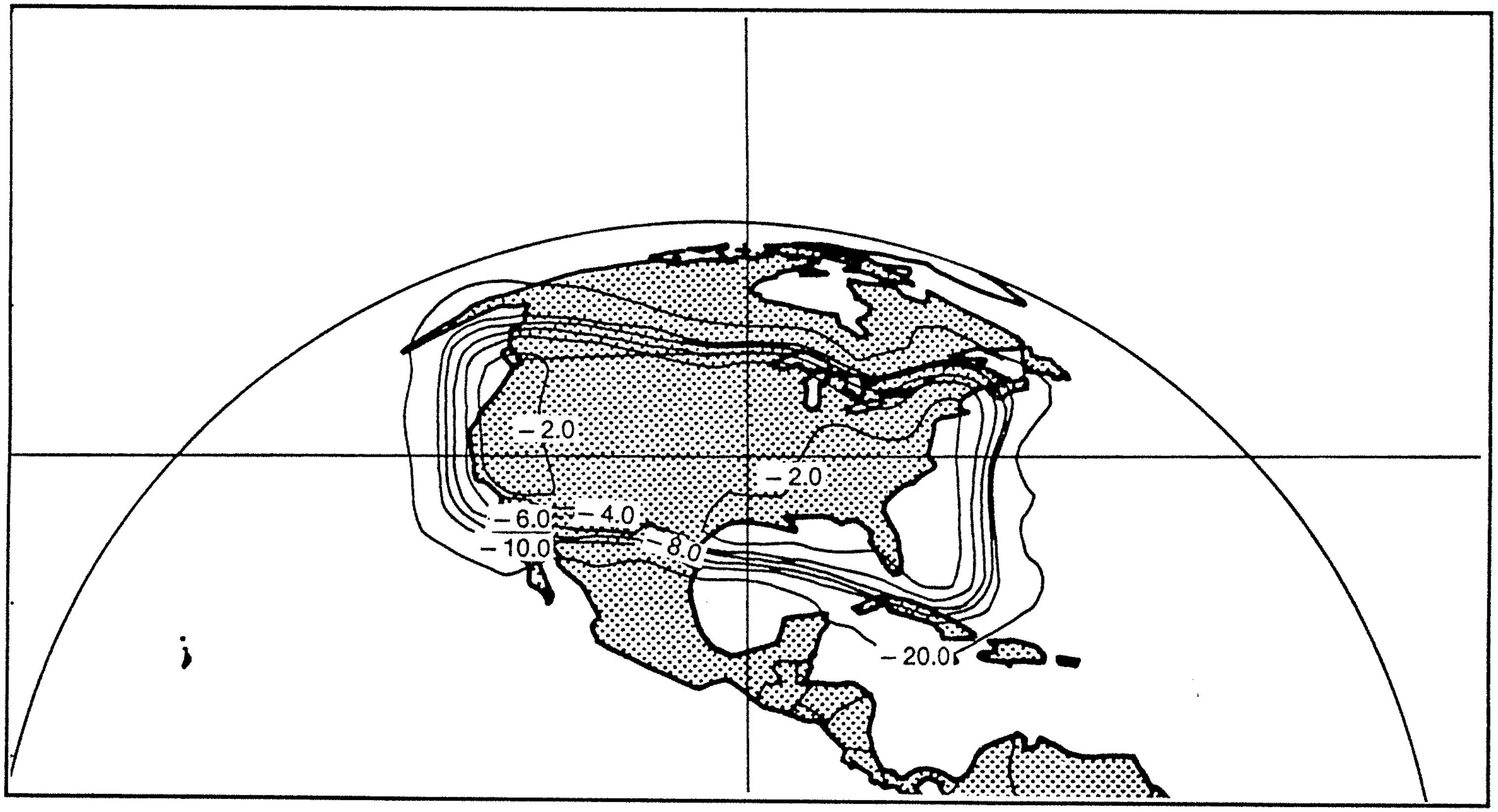

FIGURE 3d. Ku-BAND EIRP COVERAGE AT 91° W.L. (VERTICAL TRANSMIT, CONUS ONLY MODE)

PEAK EIRP = 48.3 DBW

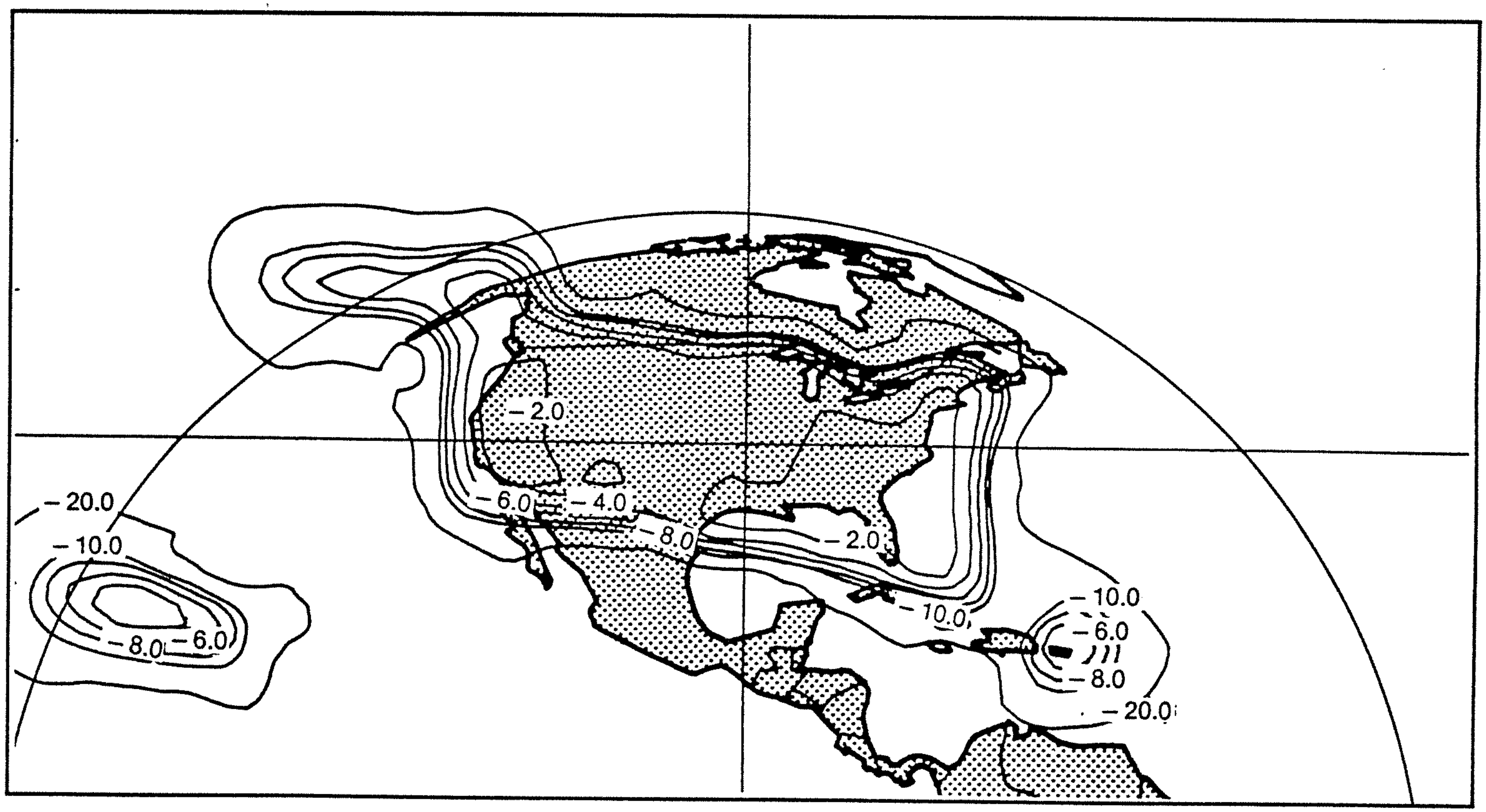

FIGURE 3e. Ku-BAND EIRP COVERAGE AT 91° W.L. (VERTICAL TRANSMIT, CONUS + OFFSHORE MODE)

2. Satellite Characteristics

The on-orbit configuration of the satellite is illustrated in Figure 4. The major spacecraft characteristics are shown below in Table 3. The estimated weight and power budgets, listed in Tables 4 and 5, are based on a mission life of 12 years and assume sufficient redundancy to allow for random failures.

Tables 6 and 7 show the estimated receive gain-to-noise temperature (G/T) and EIRP budgets, respectively.

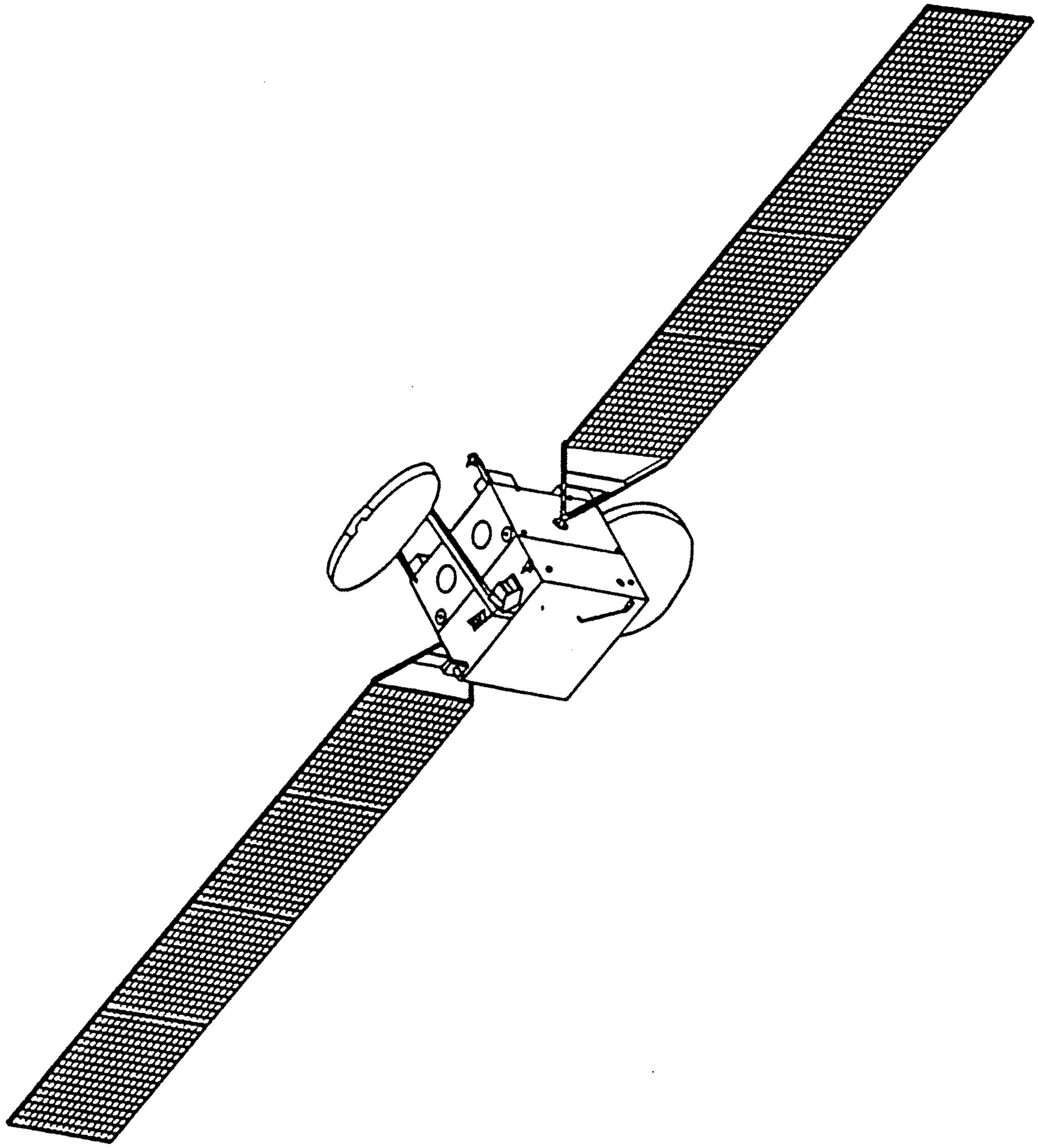

FIGURE 4. SATELLITE ON-ORBIT CONFIGURATION

TABLE 3

SPACECRAFT CHARACTERISTICS

General	
Spacecraft bus	Hughes, HS 601
Launch vehicle	Ariane, Titan, STS, Atlas
Stabilization	
Transfer orbit	Spin stabilized
On station	Body stabilized
Mission life	12 years
Design life	15 years
Eclipse capability	100 percent (48 channels)
Stationkeeping	
North-South (orbital inclination)	±0.05 degrees
East-West (longitudinal drift)	±0.05 degrees
Antenna pointing	
East-West	±0.14 degrees azimuth
North-South	±0.14 degrees elevation
Beam rotation (antenna axis attitude)	±0.25 degrees

TABLE 3 (cont'd.)

Communications	C Band	Ku Band
Frequency		
Receive	5925-6425 MHz	14000-14500 MHz
Transmit	3700-4200 MHz	11700-12200 MHz
Polarization	Hor/Ver Linear	Hor/Ver Linear
Number of transponders	24	24
Transponder bandwidth	36 MHz	27 MHz (16 ch.) 54 MHz (8 ch.)
Receive G/T (CONUS)	-1.0 dB/K	1.0 dB/K
Transponder gain (@ 0dB attenuator step)	112 dB	123.0 dB
Receive Saturation Flux Density (CONUS)	-90 to -76 dBW/m^2 (2 dB increments)	-95.5 to -78 dBW/m^2 (2.5 dB increments)
Transmit EIRP (CONUS)	38 dBW	45 dBW
Transmitter RF power	16 Watts	50 Watts
Transmitter redundancy	30 for 24	30 for 24

Emission limitations (percentage of authorized bandwidth)	
50 to 100%	>25 dB attenuation in any 4 kHz
100 to 250%	>35 dB attenuation in any 4 kHz
Greater than 250%	>61 dB attenuation in any 4 kHz

Table 3 (cont'd.)

Tracking, Telemetry and Command		
Frequency		
Command, Ranging	5925 to 5930 MHz transfer orbit 6420 to 6425 MHz on station	
Telemetry and Ranging	2 signals within 4198 to 4200 MHz	
Polarization	Transfer Orbit	On Station
Command, Ranging	Horizontal, linear	Vertical, linear
Telemetry, Ranging	Vertical, linear	Horizontal, linear
Bandwidth		
Command, Ranging	300 kHz	
Telemetry/Ranging	120 kHz	
Telemetry EIRP		
Transfer Orbit	5.0 dBW	
On Station	4.5 dBW (CONUS)	
Command Threshold (flux density)		
Transfer Orbit	-91.0 dBW/m^2	
On Station	-105.0 dBW/m^2	

TABLE 4
WEIGHT BUDGET

Category	Weight, lbs.
Communications subsystem weight	560
Bus weight	1,980
Estimated spacecraft dry weight	2,540
Margin	90
Maximum allowable dry weight (Ariane IV, shared)	2,630
Fuel, expendables	2,875
Total launch weight	5,505

TABLE 5
POWER BUDGET

Category	Power, Watts
Communications subsystem power	3,437
Bus power	341
Total Power Requirement	3,778
End-of-Life array capability (12 years)	4,133
End-of-Life Margin	355

TABLE 6

SATELLITE UPLINK G/T BUDGET

Parameter	Value	
	C Band	Ku Band
Antenna gain (Edge of CONUS) (dB)	27.9	29.1
Losses between antenna and preamp (dB)	0.5	0.4
System noise temperature (dB-K)	28.4	27.7
G/T (dB/K)	-1.0	1.0

TABLE 7

SATELLITE DOWNLINK EIRP BUDGET

Parameter	Value	
	C Band	Ku Band
Amplifier output power (dBW)	12.0	17.0
Repeater output losses (dB)	1.0	1.5
Antenna Gain (Edge of CONUS) (dB)	27.0	29.5
EIRP (dBW)	38.0	45.0

3. Satellite Description

The spacecraft bus is based upon the Hughes HS 601 series body stabilized bus. The satellite design is compatible for launch by the Ariane, Atlas and other expendable launch vehicles. The design also allows compatibility with the STS launch vehicle.

Deployment of antennas and solar cell arrays is performed in four separate steps. After launch vehicle separation and through transfer orbit operations, the bicone antenna is partially deployed in order to secure command, telemetry, and ranging functions. After the spacecraft has been injected into synchronous altitude, the bicone antenna is further deployed to its final on-orbit configuration and the solar cell array panels are extended. Finally the large communications antenna reflectors are deployed.

a. Power Subsystem

Satellite power will be provided by solar arrays of fused silica-covered silicon solar cells that convert solar energy to the required electrical power. The arrays are deployed after the satellite attains synchronous orbit.

Nickel-Hydrogen batteries provide sufficient electrical power during eclipse to operate the full communications and housekeeping loads throughout the mission life. Similar batteries are being used on Intelsat VI and other Hughes satellites. Nickel-Hydrogen battery cells have been under test since 1975. No failures have occurred at the design depth of discharge in these tests.

The electrical power subsystem has been designed so that no single failure in the subsystem will cause a spacecraft failure. Sufficient power will be available at the end of the satellite's life to support all 48 active transponder channels and the housekeeping loads.

b. Attitude Control Subsystem

The Attitude Control Subsystem (ACS) maintains the spacecraft attitude during the transfer orbit, initial acquisition period, and geostationary operations. The ACS employs sun and earth sensors to perform all attitude determination functions. The ACS will provide antenna pointing accuracy of ±0.14 degrees (North-South and East-West). Control of attitude and spacecraft orbit is accomplished by using momentum wheels and by pulsed or continuous firing of selected thrusters by the ACS during ground controlled maneuvers.

c. Propulsion Subsystem

The spacecraft will use a liquid bipropellant propulsion system. The liquid bipropellant system is based on proven technology from the Leasat and Intelsat VI programs. It provides high performance through the use of hypergolic propellant: nitrogen-tetroxide (N_2O_4) oxidizer and monomethyl-hydrazine (MMH) fuel.

d. Antenna Subsystem

The satellite antenna subsystem contains two parabolic reflectors each consisting of two polarization-selective gridded offset paraboloids sharing the same aperture. One of these reflectors is used for C band communications; the other reflector is used for Ku band communications. The four multihorn feed assemblies which feed the reflectors are frequency diplexed to allow each assembly to be used for transmit and receive functions. A minimum of 33 dB cross-polarization will be maintained over the satellite coverage area.

e. Communications Subsystem

The communications subsystem consists of two communications repeaters: a 24 channel C band repeater employing 16 watt solid state power amplifiers (SSPA's), and a 24 channel Ku band repeater employing 50 watt traveling wave tube amplifiers (TWTA's). Except for the limited frequency cross-strapping capabilities previously described, the C band and Ku band repeaters are essentially independent of each other. A functional block diagram of the C band and Ku band repeaters is presented in Figure 5.

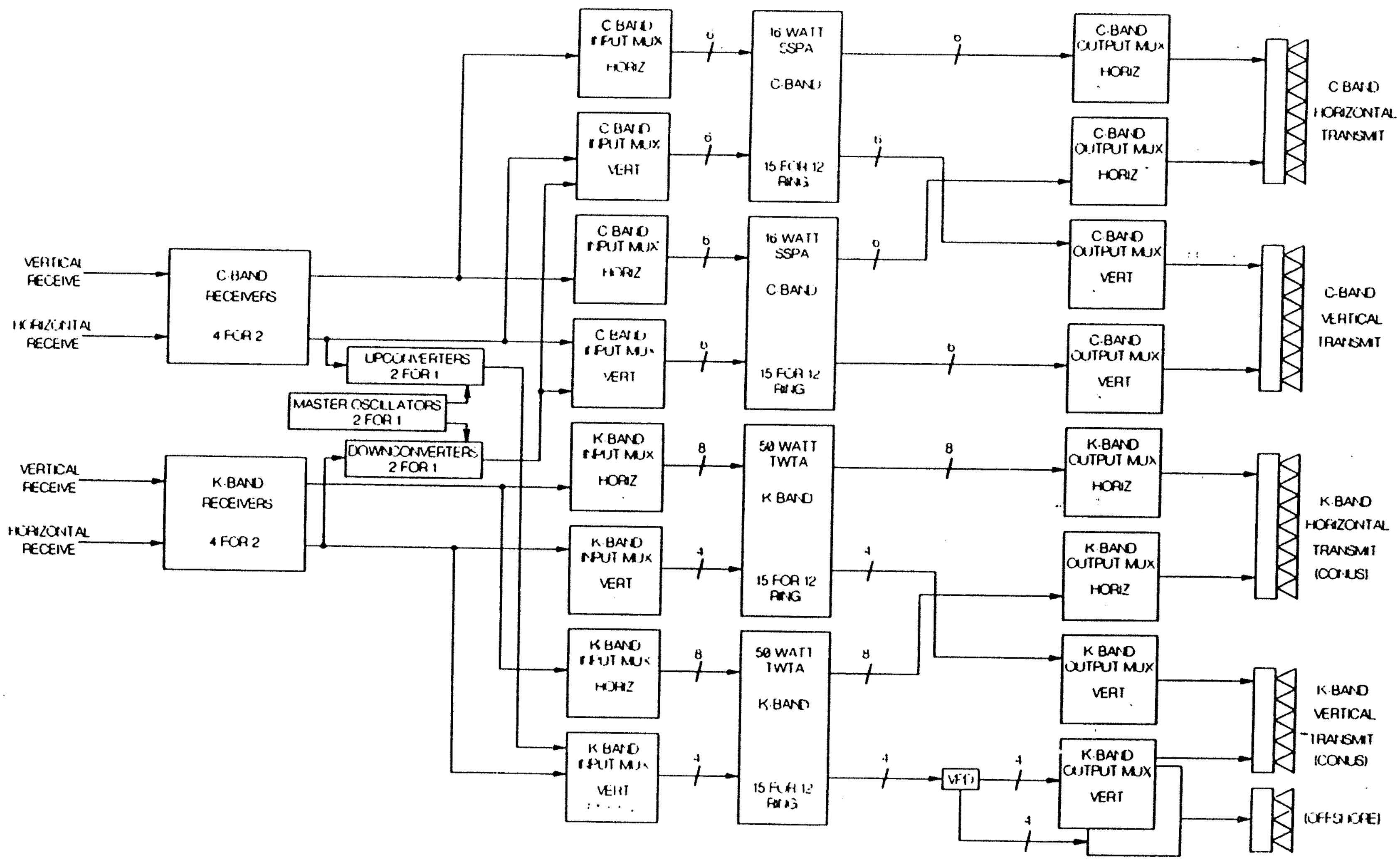

FIGURE 5. REPEATER BLOCK DIAGRAM

(i) <u>Transponder Signal Path</u>

The signal paths of the C band and Ku band repeaters are very similar. Horizontally and vertically polarized received signals are separately routed to a pair of wideband receivers. Each wideband receiver consists of a low noise amplifier followed by a downconverter which translates the input frequencies (6 GHz at C band, 14 GHz at Ku band) to the satellite transmit frequencies (4 GHz at C band, 12 GHz at Ku band). Following the downconverter is a medium-level amplifier which amplifies the translated signals to drive the final power amplifier in each transponder channel.

There are four receivers in each payload: two active receivers and two backup receivers. In case of a failure, any receiver can be switched to replace a failed receiver, thereby providing an overall four-for-two receiver redundancy for each payload.

The signals from each receiver are passed to separate channelized input multiplexers. Each input multiplexer contains twelve input filters arranged in two circulator-coupled chains fed by a hybrid splitter. Each channelized filter contains separate phase and amplitude equalization. A commandable gain step attenuator follows each input filter. In the C band repeater, the step attenuators allow each transponder's gain to be varied over a 14 dB range in 2 dB steps. For the Ku band repeater, the gain variation range is 17.5 dB in 2.5 dB steps.

Following the input filters is a bank of redundancy switches which allow spare amplifiers to be switched into the signal path as substitutes for failed amplifiers. 30 for 24 amplifier redundancy is provided in both the C and Ku band payloads. In the C band payload, amplification is provided by 16 watt SSPAs. At Ku band, amplification is provided by 50 watt TWTAs. Following the amplifier is an output redundancy network which is a mirror image of the input redundancy network.

Signals from the output redundancy switch network are routed to a set of output multiplexer assemblies. The output multiplexer provides channelized output filtering, as well as harmonic and receive-reject filtering. Signals from the output multiplexer are passed to the antenna feed network for transmission.

(ii) <u>Frequency Conversion and Stability</u>

Receive frequencies will be translated, without frequency inversion, to transmit frequencies through a net frequency subtraction of 2225 MHz at C band and 2300 MHz at Ku band. The net translation error, including initial tolerance, will not be greater than ±10 parts in 10^6 over the operating lifetime of the satellite. Variations in net translation frequency over 24 hours will not exceed a total of ±1 part in 10^6, including eclipse effects.

(iii) <u>Satellite Emission Limitations</u>

Spurious emissions that are beyond the usable bandwidth of each transponder and within the C and Ku transmission bands are attenuated by a combination of the input and output multiplex filters. Out-of-band emissions beyond the C and Ku transmission bands, including harmonics, are attenuated by a combination of the output multiplexer filter and harmonic filtering.

f. Satellite Useful Lifetime

The design lifetime of the satellite in orbit (excluding fuel limitations) is 15 years. This has been determined by a conservative evaluation of the effect of the synchronous orbit environment on the solar array, the effect of the charge-discharge cycling on the life of the batteries, and the wearout of the TWTAs. The mass allocation of propellant for spacecraft stationkeeping is 12 years. To enhance the probability of survival, spacecraft equipment will be redundant wherever possible. Materials and processes will be selected so that aging or wearing effects will not adversely affect spacecraft performance over the estimated life.

g. Satellite Stationkeeping

Inclination of the satellite orbit will be maintained to ±0.05 degree or less, and the satellite will be maintained to within ±0.05 degree of the nominal longitude position. Attitude of the satellite will be maintained to an accuracy consistent with the achievement of the specified communications performance, after taking into account all error sources (e.g., attitude perturbations, thermal distortions, misalignments, orbital tolerances, and thruster perturbations).

In addition to the propellant required for operational attitude and orbital control, extra propellant will be incorporated to provide correction of the initial orbit and initial attitude acquisition. Sufficient propellant will be included in the satellite to permit a 12-year operational life.

h. Telemetry, Tracking and Command ("TT&C")

The telemetry, tracking and command ("TT&C") subsystem will perform the monitoring and command functions necessary for spacecraft control.

(i) Telemetry

The telemetry system will have two identical links consisting of two encoders that modulate either of two transmitters via a cross-strap switch. Data pertaining to unit status, spacecraft attitude, and spacecraft performance will be transmitted continuously for spacecraft management and control. The telemetry transmitter will also serve as the downlink transmitter for ranging tones and command verification. The primary telemetry data mode will be PCM, but FM real time modes will be provided for sensor and accelerometer data. For normal on-station operation, the telemetry transmitters will be connected via a filter to the transmit feeds of the communications antenna.

In transfer orbit, each telemetry transmitter will drive one of two C-Band SSPAs selected to provide adequate EIRP for telemetry coverage via the bicone antenna. Selection of this high level mode, which may also be used for emergency backup on station, will be by ground command.

(ii) Command

The command system will control spacecraft operation through all phases of the mission by receiving and decoding commands to the spacecraft. Additionally, it will serve as the uplink receiver for ranging signals. The command uplink will employ government-approved command encryption. The command signals will be fed through a filter diplexer into a redundant pair of command receivers. The composite signal of the receivers' total output will drive a pair of redundant decoders. The decoders will provide command outputs for all satellite functions. The bicone antenna will be used in transfer orbit for command and ranging, while the reflector antenna will be used on-station for command and ranging.

(iii) TT&C Performance Characteristics

A telemetry and command summary is given in Table 3. The satellite system requires a command receiver input power of about -135 dBW for command execution. With a nominal ground station EIRP of 68 to 78 dBW, the command threshold requirements are met through the bicone and reflector antennas, respectively, as shown in Table 8. The telemetry link budget for on-station operation is given in Table 9.

TABLE 8. COMMAND LINK PERFORMANCE

Parameter	Transfer Orbit	On-Station
Command frequency	5928 MHz	6422 MHz
Uplink EIRP	78.0 dBW	68.0 dBW
Space loss	-200.0 dB	-200.7 dB
Antenna gain	-2.0 dBi	26.6 dBi
Received carrier power	-124.0 dBW	-106.1 dBW
Onboard losses	-3.7 dB	-12.4 dB
Command receiver input power	-127.7 dBW	-118.5 dBW
Receiver command threshold	-135.0 dBW	-135.0 dBW
Margin above command threshold	7.3 dB	16.5 dB

TABLE 9. TELEMETRY LINK BUDGET (ON-STATION)

Parameter	Value
Telemetry EIRP, minimum	4.5 dBW
Path loss	-196.1 dB
Atmospheric absorption (clear sky)	-0.2 dB
TT&C station G/T	30.0 dB/K
Link C/T	-161.8 dBW/K
Link C/N_o	66.8 dB-Hz
Subcarrier modulation index	-4.1 dB
Subcarrier C/N_o	62.7 dB-Hz
Telemetry E_b/N_o (bit rate = 1kbps)	32.7 dB
E_b/N_o required for 10^{-5} BER	13.4 dB
Margin	19.3 dB

i. Satellite Reliability

(i) Satellite

The satellite will be designed for an operational and mission life of 12 years. Mission lifetime is determined primarily by the amount of stationkeeping propellant that can be loaded into the tanks within the allowable launch weight and by the wearout mechanism of the TWTAs. To ensure highly reliable performance, 30 for 24 TWTA ring redundancy is provided.

Life and reliability will be maximized by using proven reliability concepts in equipment design. All subsystems and units have a minimum design life of 15 years; standby redundancy is used in the attitude control subsystem and in the communications receiver, and active redundancy is used in the power subsystem. All avoidable single-point failure modes will be eliminated. All components and subsystems will be flight-qualified, and all components will be derated in accordance with design guidelines.

(ii) Eclipse Conditions

Eclipse conditions occur when a satellite passes through the earth's shadow. Satellite outages during eclipse conditions are avoided by providing each satellite with sufficient on-board battery capacity to power all required spacecraft and communications payload functions. The battery capacity will be more than adequate to power all 48 output amplifiers during eclipses throughout the mission life.

(iii) Sun Outages

During predictable twice-yearly periods of approximately eight days, the sun briefly transits the field of view of an earth station pointing at a geostationary satellite. The rise in thermal noise in the earth station receivers caused by the sun's radiation disrupts satellite reception (i.e., causes sun outage). Such disruption of satellite reception is predictable and is well understood by satellite users.

ITEM E. Performance Requirements and Operational Characteristics of the Satellite Services

Galaxy VII(H) has been designed to support all of the various services offered within HCG's satellite system. The characteristics and associated link analyses for representative C and Ku band services are presented in Appendix E. The link budgets demonstrate that Galaxy VII(H) will allow all potential services to meet their respective performance objectives while maintaining sufficient link margin.

ITEM F. Adjacent Satellite Interference Analysis

The hypothetical interference levels generated between Galaxy VII(H) and potentially adjacent satellite systems were evaluated using the computer program commonly known as the "George Sharp" program. The results of the interference analysis are presented in Appendix F.

The analysis results demonstrate that Galaxy VII(H) does not generate any more interference than other satellite systems previously approved by the Commission. In addition, the sensitivity of Galaxy VII(H) to adjacent satellite interference is substantially equivalent to that of previously approved satellite systems. In cases where the analysis indicates an incompatibility between specific service types of Galaxy VII(H) and adjacent satellite services, such incompatibility is not due to the Galaxy VII(H) design, but is rather a fundamental characteristic of the two-degree spacing environment. Such interference situations are readily avoided or minimized through normal coordination arrangements made between the affected satellite operators.

In summary, the interference analyses establish that the design of Galaxy VII(H) is in full compliance with the requirements of the Commission's two-degree spacing order.[16/]

ITEM G. Preferred Location

HCG and STLC respectfully request that the geosynchronous orbital location of 91° W.L. be assigned to the Galaxy VII(H) satellite. This orbital location represents the current authorized position of both Galaxy VI and SBS-4 and would facilitate an orderly transition of traffic from SBS-4 to Galaxy VII(H). Continuation of satellite service at the 91° W.L. location on Galaxy VII(H)

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16. Two Degree Spacing Order, 54 Rad. Reg. 2d (P&F) 577 (1983).

would not require antenna repointing by any ground stations then oriented toward SBS-4. Considering that tens of thousands of VSAT earth stations are already pointing at SBS-4, the importance of locating Galaxy VII(H) at 91° W.L. becomes apparent. To repoint these antennas would cost a vast sum -- an unacceptable cost that could destabilize the VSAT business. See GE American Communications, 3 FCC Rcd 6871 (1988).

1. Orbital Arc Limitations

Galaxy VII(H) is intended to provide primarily video and VSAT services to Galaxy satellite users in CONUS, Alaska, Hawaii, Puerto Rico and the Virgin Islands. The 91° position offers reasonable earth station elevation angles and requires no repointing of dishes currently aimed at SBS-4. Any other assignment would frustrate the Commission's goals of continuity of service and encouragement of the necessary investment by operators.

2. Service Capabilities

Provided that Galaxy VII(H) is assigned to 91°, all C band and selected Ku band transponders on Galaxy VII(H) will be capable of providing commercial-grade service to Alaska, Hawaii, Puerto Rico and the Virgin Islands. The description of transponders, antenna beams, and other technical parameters are set forth in other portions of this Application. Services and earth station facilities would be identical to those available to users in CONUS. Transborder services may also be provided, consistent with Commission policy on Article XIV consultation with INTELSAT.

3. Use of System

Galaxy VII(H) will continue providing services previously offered by SBS-4 and Westar III/Galaxy VI. SBS-4, as previously noted, is an integral part of STLC's satellite system and is used to provide VSAT services to thousands of customers. Westar III has been used to provide video and audio distribution; its successor, Galaxy VI, is expected to do the same.

4. Miscellaneous and Alternatives

Galaxy VII(H) will be capable of orbital relocations during its lifetime to accommodate new orbital assignments by the Commission. Propellant is provided for one relocation at a rate of one degree per day. Such relocations, however, may cause extreme service disruptions because the ground network associated with Galaxy VII(H) will consist of tens of thousands of terminals.

ITEM H. Schedule

1. Required Availability

The required launch date of Galaxy VII(H) is December, 1992.

2. Contract Execution

The dates by which contracts are expected to be executed for the following matters are as follows: