Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of

Amendment of C-Band Satellite	RM-7627
Orbital Spacing Policies to Increase	RM-7628
Satellite Video Service to the Home	

REPORT AND ORDER

Adopted: January 2, 1992; Released: January 15, 1992

By the Commission:

I. INTRODUCTION

1. Two petitions for rulemaking have been filed with the Commission requesting that it alter its orbital spacing policies for domestic fixed-satellites. Current policy provides that separations between satellites will be two degrees by the mid-1990s when all authorized facilities are expected to be launched and operating. The petitions request that spacings between at least some satellites be allowed to remain at three degrees to facilitate the use of smaller antennas for home reception of video programming.

2. The first petition was filed by the Satellite Dealer Forum and K-Sat Broadcasting (K-Sat petition). The second petition was filed by a group of twelve entities that includes satellite equipment manufacturers and retailers, satellite programming distributors, and a programming provider (GIC petition).[1] The petitions were opposed by a number of parties including licensees of satellites proposed to be located 3 degrees apart.[2] Based on the record compiled, we find that granting petitioners' requests for rulemaking would not be in the public interest because 3^0 orbital spacings would cause unnecessary costs, severe disruption, uncertainty and instability in the satellite industry and would not achieve the ultimate benefits sought by the petitioners. Accordingly, the petitions for rulemaking are denied.

II. BACKGROUND

3. The move to 2^0 spacing was initiated ten years ago when the Commission determined that the best way to accommodate increased demand for satellite transponder capacity would be to maximize the use of the orbit by providing for the launch of more satellites.[3] The Commission noted that this demand stemmed in part from the development of new and innovative equipment and services offered by an increasing number of entrepreneurs in the industry. It expressed concern that regulatory policies continue to assure availability of satellite capacity to satisfy current needs as well as encourage new entrants in this market. The Commission stated that it initiated the 2^0 spacing rulemaking at that time in order to resolve the question of orbital spacings prior to the launch of additional new or replacement satellites. It emphasized that the smallest practical orbital spacing should be selected in order to conserve the orbital arc.[4]

4. In 1983, the Commission adopted its 2^0 spacing policy.[5] In doing so, it recognized that an immediate implementation of reduced spacing in the C-band would pose serious difficulties and cause significant costs. It therefore decided on a transitional plan with 2^0 as an ultimate goal but with a longer implementation schedule to allow operators several years to amortize and upgrade or replace existing facilities.[6] The Commission also noted that the parties commenting in that proceeding conceded that spacings of less than three degrees were ultimately necessary to accommodate demand. It also noted that licensees preferred incurring the costs necessary to implement 2^0 spacing to the costs and delays of comparative hearings which might be used to choose among applicants if the demand for orbital locations exceeded their supply.[7]

5. Receive-only earth stations were deregulated in 1979 when the Commission established an optional licensing program for those desiring interference protection from terrestrial microwave facilities operating in the same band while allowing those not desiring such protection the right to use unlicensed facilities.[8] Most owners of home satellite earth stations (HSDs) choose not to license their equipment.[9] Because of their unlicensed status, the potential affect of 2^0 spacing on HSDs was not evaluated in *Reduced Spacing*.[10]

6. In 1985 and again in 1988 the Commission reaffirmed its commitment to 2^0 spacing when assigning orbital locations to new space stations.[11] The Commission referred to the uniform 2^0 policy as the "cornerstone of our orbital assignment policy" designed to maximize the

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[1] Petitioners are: Channel Master Division of Avnet, Inc. (Channel Master); Chaparral Communications, Inc. (Chaparral); Consumer Satellite Systems, Inc. (Consumer Satellite); Earth Terminal TV, Ltd. (Earth Terminal); General Instrument Corporation (GIC); the National Rural Telecommunications Cooperative (NRTC); PrimeTime 24 (PrimeTime); the Retail Council of the Satellite Broadcasting and Communications Association (Retail Council); Satellite Receivers, Ltd. (Satellite Receivers); Satellite Sports Network (SSN); Warren Supply Company (Warren) and Winegard Company (Winegard).

[2] *See* Appendix A for list of Commenters.

[3] Licensing of Space Stations in the Domestic Fixed-Satellite Service and Related Revisions of Part 25 of the Rules and Regulations, 88 FCC 2d 318 (1981) (*Reduced Spacing Notice*).

[4] *Id.*

[5] Licensing of Space Stations in the Domestic Fixed-Satellite Service and Related Revisions of Part 25 of the Rules and Regulations, 48 Fed. Reg. 40233 (1983) (*Reduced Spacing*).

[6] *Id.* at para. 41.

[7] *Id.* at para. 18.

[8] Deregulation of Receive-Only Earth Stations, 74 FCC 2d 205 (1979).

[9] The Commission recently adopted a registration program for domestic receive-only earth stations to replace optional licensing for facilities where interference protection is desired. *See* 47 C.F.R. 25.131.

[10] *See Id.* at note 31.

[11] *See* Assignment of Orbital Locations to Space Stations in the Domestic Fixed-Satellite Service, 50 Fed. Reg. 35228 (August 30 1985) (*1985 Assignment Order);* Assignment of Orbital Locations to Space Stations in the Domestic Fixed-Satellite Service, 3 FCC Rcd 6972 (1988) (*1988 Assignment Order*).

number of satellites that could be authorized in order to assure that the demand for satellite services could be met.[12]

7. The entities authorized to construct and launch space stations in 1988 have begun to implement their proposed facilities.[13] Many of these satellites are scheduled to be launched in the next three years and are assigned to orbital locations with 2^0 separations although the satellites they are replacing are currently operating in locations spaced further apart.

8. Two groups have filed petitions for rulemaking requesting changes in our orbital spacing policies. The K-Sat petition lists four reasons why it is in the public interest to change our spacing policy from 2^0 to 3^0.[14] These are as follows: 1) 3^0 spacing would allow the use of smaller C-band reception antennas that would not be adversely affected by adjacent satellite interference, 2) smaller dishes would reduce zoning conflicts, 3) 3^0 spacing would allow for "an interim transition to Ku-band specialized packages while preserving high powered steerable C-band use", and 4) for "other unmentioned reasons". This petition does not contain elaboration or supporting information.

9. The GIC petition was filed by a group of entities with varying interests in the market for satellite delivered video programming. It requests the initiation of a rulemaking that would lead to the adoption of 3^0 spacing in certain portions of the arc at C-band as well as the adoption of any other changes that would facilitate the use of smaller earth stations. GIC asserts that demand for C-band transponder capacity has decreased since 2^0 spacing was adopted and, therefore, wider spacing between satellites providing entertainment video services can be maintained. GIC contends that 3^0 spacing will help the development of the HSD industry by allowing the use of smaller antennas. In reply comments, GIC clarifies its position and states that the petition is requesting maintenance of spacings at 3^0 for the life of currently authorized satellites carrying cable programming, *i.e.*, approximately a ten year period.

10. The GIC petition offers two alternative proposals for 3^0 assignment plans for satellites located in the western portion of the orbital arc.[15] Satellites of primary concern are those that carry video programming for distribution to cable systems as well as HSDs and that are currently assigned to locations between 137^0 W.L. and 125^0 W.L.[16]

11. Fourteen oppositions to the petitions were filed.[17] Other parties filed pleadings captioned as comments that expressed opposition to the petitions. Opponents include satellite operators, non-entertainment video users of satellite services and certain video programmers. Comments supporting the petition were filed by entities involved in the manufacture of HSD equipment as well as by some programming providers.

III. DISCUSSION

12. After balancing the benefits petitioners claim will accrue from their requested change against the costs and disruption the change would cause in the satellite industry overall, we conclude that instituting the proposed rulemaking would be contrary to the public interest. Both petitions fail to demonstrate sufficient reasons to justify the consideration of such a major policy shift. Maintaining 3^0 spacing, even in only part of the orbital arc, would not achieve the result sought by the petitioners because of technical limitations, would cause major costs, disruption and uncertainty in the satellite industry and would result in a substantial loss of regulatory flexibility.

A. Technical Considerations

13. GIC's position that 3^0 spacing should be permitted in certain portions of the arc is premised on certain technical assumptions regarding the feasibility of using four foot diameter antennas to receive video signals at C-band. GIC claims that advances in satellite technology now make the use of antennas four feet or less feasible as long as adjacent satellite interference can be adequately rejected. Petitioners assert that with 3^0 spacing, four foot antennas will be able to provide an acceptable quality picture but that if spacings are reduced to 2^0, antennas will have to be larger. They cite the fact that many of the new satellites recently authorized will be transmitting with 16 watts of power per transponder in contrast to the present facilities operating with 5 to 10 watts of power. They conclude that these higher power levels contribute to the feasibility of smaller dishes. In addition, petitioners assert that other advances in transistor technology make smaller HSD receivers more efficient.

14. Attached to the petition is a technical analysis supporting the contention that under 2^0 spacing conditions, an eight foot antenna is necessary to reject adequately adjacent satellite interference. This analysis purports to demonstrate that if satellites remain at 3^0 spacing, four foot antennas would provide adequate reception. Petitioners also indicate that they have been operating two experimental four foot HSD systems in California and have included the results of these experiments in their analysis.

15. Opponents dispute the petitioners' assertions that four foot antennas will provide an acceptable quality picture with 3^0 spacing and offer several technical analyses in support. Although their conclusions vary as to the minimum size antenna necessary, all question the petition's

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[12] *1988 Assignment Order* at para. 5.

[13] Satellite construction schedules require long lead times. The space stations authorized in our 1988 orders were generally required to be constructed and launched by 1994. *See* general discussion of this policy in Licencing Space Stations in the Domestic Fixed-Satellite Service, 50 Fed. Reg. 36071 (September 5, 1985) at paras. 26-28.

[14] The petition is unclear about whether it is requesting a change in all portions of the arc in both bands, in the entire C-band orbital arc, or only in part of the C-band. C-band refers to 3700-4200 MHz downlink pared with 5925-6425 MHz uplink. Ku-band refers to 11.7-12.26 GHz downlink with 14 GHz uplink.

[15] The portion of the geostationary satellite orbital arc in question is that between 120^0 W.L. and 142^0 W.L. at C-band.

[16] These include GE's Satcom C-1, C-2, and C-3 satellites and Hughes's Galaxy V and Galaxy IR satellites. Four of these satellites are assigned locations within seven degrees of each other; Satcom C-1 at 137^0 W.L., Satcom C-4 at 135^0 W.L., Galaxy IR at 133^0 W.L. and Satcom C-3 at 131^0 W.L.

[17] Many oppositions and comments were addressed to both petitions and, unless specifically noted, in order to avoid confusion, we will refer to both petitions collectively in this order.

four foot claims.[18] Based on opponents' technical assessments, they conclude that larger antennas are necessary for adequate reception with 3^0 spacing. Opponents claim that petitioners' technical analysis fails to consider several relevant factors that impact on the feasibility of their proposal.

16. Based on an evaluation of the record compiled here as well as on an independent staff analysis, we conclude that even with satellite spacings of 3^0, a four foot antenna will provide a picture of only marginal quality, *i.e.,* a picture with discernable sparkles, in some portions of the country and will be incapable of providing even a marginal quality picture in other portions of the country.[19] In addition, more expensive consumer equipment may be necessary. In view of this conclusion and considering the anticipated costs and disruption and the potentially adverse impact that a change in policy would have on our regulatory flexibility, dismissal of these petitions is warranted.

17. Another technical concern raised by opponents stems from GIC's proposed assignment plans, both of which would create a situation where satellites with the same polarization would be adjacent to each other. Adjacent C-band satellites currently are required to have opposite transponder polarizations in order to reject interference under 2^0 spacing conditions.[20] Opponents assert, and petitioners do not refute, that even with 3^0 spacing, adjacent satellites must have opposite polarizations to avoid unacceptable interference. They note that the only way of avoiding this interference if satellites are co-polarized is to reduce transponder power substantially. Opponents conclude that this power reduction would adversely affect the ability of smaller dishes to receive signals and thus would be contrary to the results desired by the petitioners. They contend that changing the polarization of the satellites involved would be extremely costly, if not impossible at this stage. In reply, GIC states that satellite operators have been on notice that switchable polarization might be required and thus they should have constructed their satellites accordingly. It also questions the assertions by GE about costs and difficulties of changing polarization on partially constructed satellites.

18. We find that the problem of incompatible polarization is a serious flaw in both of the proposed assignment plans offered by petitioners. We agree that even with 3^0 spacing, satellites must be cross-polarized to operate effectively. There currently is no requirement that satellite operators construct their facilities with switchable polarization.[21] The present generation of spacecraft was authorized without requiring polarization switches and the 1988 Orbital Assignment Plan alternated assignments of horizontally and vertically polarized satellites. Any modification of this assignment plan will have to take polarization of adjacent satellites into account.[22]

19. An additional issue raised here involves the use of other frequencies to provide video services directly to consumers' homes. As opponents point out, spectrum in other frequency bands has been allocated exclusively to the provision of direct-to-home video service (DBS). Although this service is not yet in operation, it has the potential of providing video programming directly to consumers' homes using very small and inexpensive antennas.[23] In addition, at least two video programming services are scheduled to be offered in the Ku-band[24] where smaller antennas in the range of two feet are technically feasible.[25] Use of the Ku-band and DBS[26] in the bands established for that purpose will, according to opponents, accomplish the result sought by petitioners, *i.e.,* smaller antennas at less cost to the consumer, without causing the disruptions and costs anticipated by relocations in the C-band.[27]

20. GIC replies that direct-to-home video programming services in Ku-band have not been established and are only in the test marketing stage and thus are not at this time a viable substitute for C-band services which carry "name brand" programming designated for cable distribution.[28] GIC states that programmers are committed by contract to transponders in the C-band for at least ten years and thus Ku-band is not a realistic option for dish owners. GIC also questions whether DBS will ever be implemented.

21. Although neither Ku-band direct-to-home service nor DBS service are as yet fully established, we expect that as these technologies develop, they will become viable alternatives to Cband HSD service. Until that time, most HSD consumers are not faced with a choice of doing without service altogether. Instead, by using somewhat larger antennas, they, along with the other services using C-band, are ensuring that orbital spectrum is efficiently used and that all users can sucessfully co-exist.

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[18] GTE states that some 5 to 7 foot antennas might work in some "best case" situations with 3^0 spacing. GE states that an 8 foot antenna would be required to achieve adequate results with 3^0 spacing. Hughes states that because no industry-wide standard for minimum quality video signals has been established, it cannot be determined if 4 foot antennas will perform adequately even with 3^0 spacings. The petition and our discussion is based on an analysis of the feasibility of 4 foot antennas. Standard antenna size feasible for most areas of the country under 2^0 spacing conditions is 8 feet to 10 feet.

[19] *See* Appendix B for the staff's technical analysis.

[20] *See* Licensing of Space Stations in the Domestic Fixed-Satellite Service and Related Revisions of Part 25 of the Rules and Regulations, 99 FCC 2d 737 (1985) at para. 6.

[21] Such a requirement is under consideration. *See* Amendment of Part 25 of the Commission's Rules and Regulations, 2 FCC Rcd 762 (1987).

[22] With respect to the costs involved in redesigning spacecraft, GE has provided in its comments a detailed explanation of the difficulties and expense involved in redesigning polarization in substantially constructed facilities and the record does not indicate that this description is incorrect.

[23] Comments of USSB.

[24] See GE Americium Communications, Inc., 3 FCC Rcd 6871 (1988) for discussion of establishment of "high-density" arc at Ku-band for direct-to-home video service.

[25] Prime Star has begun test marketing its Ku-band service in certain parts of the country and SkyPix is scheduled to begin service in the near future.

[26] The Commission has allocated the 12.2-12.7 GHz frequency band for DBS.

[27] With respect to zoning problems encountered by HSD owners, the Commission is currently considering a Petition for Declaratory Ruling filed by the Satellite Broadcasting and Communications Association of America specifically addressing these issues.

[28] See also Reply Comments of Chapparal contending that the program offerings on Ku-band are limited.

B. Cost and Disruption

22. The GIC petition asserts that circumstances have changed since the Commission adopted its 2^0 spacing policy. GIC states that when 2^0 spacings were adopted in 1983, demand for transponder capacity in the C-band was high. Since then, some of the traffic carried by satellites has been transferred to fiber optic cable. Several planned C-band systems never were implemented, and the ownership of fixed satellites has been consolidated and concentrated in a few major licensees. The pressure for C-band transponder expansion has disappeared, according to petitioners, and growth has been stronger in the Kuband. The GIC petition contends that the only growth at C-band has been in the video distribution market. GIC states that they are not requesting that 3^0 spacing be maintained indefinitely. Rather, their petition requests that 3^0 spacing be implemented for the life of the next generation of spacecraft, approximately ten years. They contend that the Commission should reevaluate the spacing situation when it considers future applications for space stations proposed to be launched after this ten year period.

23. The petition also states that while the need for 2^0 spacing has subsided, the benefits to be derived from the use of smaller receiving antennas have increased. It asserts that the HSD market is strongly affected by the size of the receiving antenna that can be used. GIC claims that with the 8 to 10 foot antennas currently used, it is anticipated that the market will expand from approximately 2.6 million to 4 million earth station owners over the next five to eight years. With dishes 4 feet or less, it estimates the market could grow to 10 million in the same time period. Smaller dishes will, according to the petition, eliminate some of the local zoning problems that many HSD owners are experiencing.

24. Opponents argue that the demand for C-band transponders is not declining. For example, one satellite operator states that the four primary cable satellites have been over 70 percent presubscribed prior to launch.[29] Other commenters assert that contrary to petitioners' claims, introduction of new technologies such as digital video compression will increase rather than decrease demand for C-band transponders by increasing opportunities for new services.[30] Because an expansion in spacing will decrease the number of orbital locations available for domestic satellite use,[31] commenters fear that a transponder shortage will result which will stifle the growth of new services as well as drive up the price of satellite capacity. Opponents argue that the GIC petition has failed to demonstrate that the market for C-band transponders is so diminished that a 20% reduction in capacity[32] that would result from increased spacing will not adversely affect services. They also state that relocations at C-band will impact Ku-band services and transponder availability as well.[33]

25. It is not clear, based on this record, whether there is now an excess of transponder capacity at C-band.[34] It is even less clear what the future use of this band will be.[35] In the past, new and innovative satellite services have been introduced at C-band as technology has developed and we have no reason to believe that this trend will not continue. Under these circumstances, we cannot conclude that demand is so reduced that restricting capacity to the extent suggested by petitioners is warranted.

26. Opponents of the petition also cite significant costs that they will be forced to incur if spacing policies are changed. Since adoption of 2^0 spacing in 1983, industry participants have been preparing for its full implementation and have already expended considerable time and money on transition plans to accommodate operations under 2^0 spacing conditions. Additional costs would be incurred if spacings were to be changed to 3^0 and operators had to adjust their equipment accordingly. These include the costs of repointing antennas[36] and modifying spacecraft currently under construction[37] Significantly, many of these opponents are participants in the HSD industry.[38]

27. GIC asserts that opponents should be required to document the costs and economic impact they claim will result from a change in spacing policies. Such documentation would include, according to GIC, contracts claimed to be disrupted. In addition, GIC challenges opponents to document costs of repointing antennas.[39]

28. Alascom states that a service that would be adversely affected by petitioners' proposal to relocate Aurora 2 would be telephone service to the bush communities of Alaska. Antennas serving these communities are not steerable and it would take two to four weeks to repoint

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[29] Comments of GE.

[30] Comments of GE, Hughes. These parties caution that the introduction of digital compression technology will necessitate expensive installation of new ground equipment and that such expense may delay implementation. Commenters state that most major programmers have binding contracts for full transponders and that once compression techniques are available, the industry will use the resulting extra capacity to accommodate new services.

[31] Hughes states that the GCI petition's proposal will result in the loss of three orbital locations in the western portion of the arc.

[32] GE estimates that petitioners' plans will have this effect.

[33] Comments of GTE.

[34] USSB states that there is no evidence of a decrease in demand for C-band capacity. Hughes states that C-band transponders are heavily used. ARC states that demand varies at peak hours and that any measurement of usage conducted during off-peak hours must take this fact into consideration. IDB states that there is a shortage of C-band transponders for video services, particularly for occasional video use.

[35] Commenters argue that new technologies will be implemented at C-band.

[36] *See* Comments of ABC.

[37] *See* Comments of GE.

[38] *E.g.,* HBO and C-Span provide programming that is sold to HSD customers. GE and Hughes are licensees of satellites that serve cable as well as HSD customers.

[39] Specifically, GIC states that challengers should document the costs incurred as a result of relocations occasioned by the recent demise of Alascom's Aurora 1 satellite. When this satellite became nonfunctional, emergency measures were taken to relocate temporarily Alaskan telephone traffic until its replacement, Aurora 2, was launched. GIC claims that documentation of these costs will give an accurate indication of the actual expenses involved in repointing antennas.

them, assuming good weather. This process would cause temporary suspension of telephone service in these isolated areas.[40]

29. In addition, many opponents are concerned that relocation of satellites under GIC's proposals will prevent certain satellites from providing 50 state coverage.[41] For example, satellite users are concerned that both of the petitioners' proposed assignment plans require Aurora 2 to move from 139^0 to 142^0.[42] These users contend that this move would adversely affect the majority of radio networks using that satellite. They assert that they have contracts for the distribution of radio programming which are based on the satellite's ability to cover all 50 states and relocation would severely disrupt these business arrangements. They also state that these services must be carried on one satellite in order to be efficiently delivered.[43] GE states that if its satellites are relocated, it will cost $1000 to repoint each of its 3000 antennas used to provide radio programming.[44]

30. We agree with a major concern of opponents that a change in satellite spacing policies at this time will result in significant cost and disruption to an industry that is, by its nature, subject to substantial risks.[45] As one provider of video services stated," the very filing of the Petition perhaps jeopardizes or at least casts a cloud of uncertainty over the elaborate and complicated transition plans."[46] Petitioners' proposal that 3^0 spacing be imposed as a temporary measure will only compound the uncertainty generated by a policy shift that may be reversed in ten years.[47] We believe that the disruption and uncertainty that will be generated by increased spacing is not justified, especially where proposed changes will only assist a discrete segment of users to the detriment of other users and where the alleged benefits are speculative.[48] We also agree with those opponents who state that it is very late in the implementation process to be proposing a change in satellite spacings.[49]

31. On balance, based on the record before us, we find that the costs and disruption that would result from even a temporary change in our spacing policy would be significant.[50] Although we have stated that orbital locations are not assigned permanently and are subject to change upon thirty days notice,[51] we have also attempted to avoid unnecessary disruption and relocation in this highly capital intensive market.[52] In reaching this conclusion, we recognize the public interest potential of satellite delivered video programming services as a competitive alternative to cable,[53] but the result requested by the petitioners will cause potential economic harm to other users of satellite services and may not offer the benefits that petitioners predict.[54] Judging from this record, a change in satellite spacing is supported primarily by those involved in C-band video programming distribution directly to individual homes.[55] Other providers and users of satellite services are strongly opposed, including those operators of space stations that would be located 3^0 apart and who might derive some potential benefits from a relaxed interference environment.[56] Public interest considerations, based on an evaluation of the entire satellite industry, do not support granting these petitions.

C. Loss of Regulatory Flexibility

32. Another major concern articulated by opponents is that a change in spacing policy may adversely impact the traditionally flexible regulatory policies the Commission has applied to the satellite industry. Opponents cite the

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[40] Comments of Alascom.

[41] *See, e.g.,* comments of Viacom, C-Span, GE, ABC and Alascom for additional concerns about 50 state coverage.

[42] *See, e.g.,* comments of ABC, Westwood One, Inc., CBS. Opponents say a satellite located at 142^0 W.L. will not be able to provide service to most of New England while GIC asserts that only the northernmost tip of Maine will be affected. Under one of petitioners' proposals, GE's Satcom C-1 would be relocated to 140^0 W.L. where GE states it will be unable to provide 50 state coverage. Our calculations suggest that service from locations west of 139^0 W.L. may be marginal in parts of New England.

[43] Comments of ABC.

[44] GIC cites information that the digital audio tape (DAT) technology used to deliver these radio services may be abandoned. However, this is not confirmed in the record and does not answer opponents' general concerns about disruption of radio services caused by relocations.

[45] For example, space station facilities requiring expenditures of approximately $100 million are subject to launch and in-orbit failures.

[46] Comments of HBO. GTE states that perceptions of predictability and stability are critical factors in consumer choices of telecommunications systems and that relocations could cause users to reject satellite-based facilities in favor of terrestrial facilities.

[47] ARC states that if companies invest in equipment that will be compatible with 3^0 spacing, it will be difficult and expensive to replace this equipment if spacings are changed back to 2^0 at a later date.

[48] Comments of AT&T and Alascom.

[49] *See* Comments of HBO. Hughes states that five of the satellites of most concern if 3^0 spacing is to be implemented will be launched by late next year and that any change in spacing will require costly in-orbit relocations. GE states that GIC's concerns should have been raised eight years ago in a petition for reconsideration of *Reduced Spacing*. GTE points out that although petitioners state that they have tried to minimize relocations, their plans do not take into account the phased-in launch schedules of the various satellites involved and the fact that not all orbital locations will be available at the same time.

[50] The burden is on the petitioner to demonstrate the justification for the institution of a rulemaking and the record here indicates that the costs of relocation of satellites on a scale requested by the Petitions would be substantial.

[51] *See, e.g.,* Hughes Communications Galaxy, Inc., 3 FCC Rcd. 6989 (1988) at para. 23.

[52] *See* GE American Communications, Inc., 3 FCC Rcd. 6871 (1988) at para. 11. See also comments of Hughes regarding the amount of investment necessary.

[53] *See* Competition, Rate Deregulation and the Commission's Policies Relating to the Provision of Cable Television Service, 5 FCC Rcd 4962 (1990); Inquiry into the Existence of Discrimination in the Provision of Superstation and Network Station Programming, 6 FCC Rcd 3312 (1991).

[54] GIC submitted a market study with its reply comments that was based on a telephone survey of HSD retail dealers and reflects their opinion that they might sell more equipment if the size of the antenna were reduced. It is also questionable whether four foot antennas will provide adequate service under 3^0 spacing. *See discussion supra* at Section A.

[55] GTE states in reply comments that opposing parties comprise virtually all the domestic fixed satellite licensees, major users and resellers of satellite capacity and DBS licensees.

[56] *See, e.g.,* comments of Hughes and GE, operators of satellites that would be spaced at 3 under petitioners' proposals.

fact that if spacings are not uniform throughout the orbital arc, satellite locations can no longer be considered fungible.[57] Consequently, locations spaced 3^0 apart would be more desirable than those spaced 2^0 apart because of reduced mutual interference and comparative hearing procedures might be necessary to evaluate applicants for particular locations. In addition, reserving 3^0 locations for those involved in distribution of entertainment video might have the effect of establishing a monopoly for video service providers with little opportunity for entry or exit in the market without relocating facilities. Opponents argue that such an approach would not be consistent with the "open skies" policies traditionally applied to this industry which enable the Commission to accommodate expeditiously all qualified applicants[58] and enables all licensees to determine which services they will provide. GIC responds that because its proposed assignment plan is only temporary, hearings to authorize new facilities would not be necessary.

33. We believe that any spacing policy that establishes different interference environments for different classes of operators and users without significant public interest benefits would undercut the traditional flexibility that has been the basis of our regulation of the satellite industry. GIC's proposal that 3^0 spacing be instituted only as a temporary measure does not relieve the situation. Operators would still be under different constraints depending on the service they are offering for at least ten years. In addition, competing applications for particular orbital locations, even for replacement satellites, in the part of the arc where 3^0 spacing is in effect, might be mutually exclusive and thus subject to the cost and delay of hearing requirements. Absent the imposition of a moratorium on applications for the western arc at C-band for a limited time, there is no guarantee that such applications will not be filed in the next several years and that we would not be faced with the prospect of costly and time consuming comparative hearings as well as disruptive reevaluation of spacing policies. We also agree that a policy which establishes spacing based on the type of service offered at one point in time would have the effect of reserving orbital locations based on private business arrangements which might be changed. For example, satellites carrying video traffic today may be used for other services in the future.[59] Such a policy is inconsistent with our flexible regulatory approach to this industry.

34. Opponents also fear that a reduction in the number of orbital locations caused by the expansion of spacings will impact on the Commission's ability to accommodate new technologies either at C- or Ku-band.[60] They state that by changing the spacing of satellites at C-band, the number of hybrid locations available for assignment to satellites operating in both bands will be reduced because spacings will no longer be coincident.[61] Although GIC offers its opinion that hybrid satellite locations may not be in demand, noting that there are no currently pending applications for hybrids and that hybrids may be too heavy to launch economically, other commenters disagree. In particular, Hughes states that hybrid technology is economically efficient and cites its recent authorizations to consolidate four single-band space stations into two state-of-the-art hybrid space stations.[62] In addition, under both of GIC's proposals, one authorization, that of NEX's Spotnet 2 satellite, would have to be cancelled.[63]

35. Further, both of petitioners' proposed assignment plans would place a U.S. satellite at 122^0 W.L. instead of 123^0 W.L. and would reduce the space between the U.S. satellite and a Canadian satellite from 4.3 degrees to 3.3 degrees. The petition notes that this change may require bilateral negotiations between the U.S. and Canadian governments but indicates that there should be no technical objection from Canada and that any problems should be resolvable. In contrast, GTE, the operator of the satellite currently located at 120^0 W.L. and a participant in bilateral negotiations with Canada, strongly asserts that any renegotiations of the agreements in question would probably be unsuccessful.[64]

36. Based on the record before us, we conclude that a retreat from our long established policy of 2^0 satellite spacings would have a severe impact on our regulatory policies in this area. Although this impact might not, by itself, be determinative in deciding to dismiss the pending petitions, when coupled with the fact that such a change would result in substantial costs and disruption to the majority of satellite industry participants and with the significant questions that have been raised about the technical assumptions and feasibility of petitioners' proposals, it lends further support to our conclusion that consideration of a change in satellite spacing policies is not in the public interest.

IV. CONCLUSION

37. We conclude that grant of the petitions would not be in the public interest. Our technical evaluation of petitioners' proposals indicate that four foot antennas will not produce an acceptable quality picture under 3^0 spacing conditions and that higher cost consumer equipment

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[57] See 1988 Orbital Assignment Order, *supra* note 11 at para. 3, for a general discussion of fungibility.

[58] Comments of Hughes.

[59] See comments of GTE regarding establishment of a monopoly for the video distribution business.

[60] Comments of Alascom.

[61] Comments of Hughes, GE, GTE.

[62] Hughes Communications Galaxy, 6 FCC Rcd 72 (1991), 5 FCC Rcd 3423 (1990). See also comments of GTE and AT&T regarding the benefits of hybrid technology.

[63] National Exchange (NEX) has filed for an extension of time in which to begin construction of this satellite, which is still pending. GE states that if NEX's request for an extension of time is denied, it would be interested in applying to use the hybrid location at 127^0 W.L. The authorization of another hybrid satellite which was assigned to a location in this portion of the orbital arc, Contelsat-2 at 128^0 W.L., was relinquished by GTE Spacenet Corporation after the petitions were filed. *See* Letter to Secretary from Terri B. Natoli, July 24, 1991. This letter also indicates that the operational life of ASC-1, the satellite that Contelsat-2 was supposed to replace, will be longer than expected and thus the relinquishment of the Contelsat-2 authorization will not necessarily result in a vacant orbital location in the near future.

[64] See Comments of GTE for description of difficulties involved in such international negotiations. Because such a move would impact on a trilateral agreement with the U.S., Canada, and Mexico, negotiations would also have to include the Mexican government.

will be required. In addition, establishing 3^0 spacing, even in only part of the orbital arc, will cause major costs and disruption to satellite licensees and to users of satellite services. Such costs include the necessity to repoint antennas, to modify spacecraft under construction and to modify long range operating plans. Relocations necessitated by 3^0 spacing would cause certain satellites to lose their ability to serve all 50 states and would adversely affect the delivery of certain services, contracts for which were based on 50 state coverage. Disruption to customers of satellite operators, including those providing essential telephone service, would be significant. Finally, a change to a 3^0 spacing policy would impact flexible Commission regulatory policies by establishing different user classes, by reducing the number of C-band and hybrid orbital locations and by necessitating the reopening of international treaty negotiations.

38. ACCORDINGLY, pursuant to Section 1.407 of the Commission's rules, 47 C.F.R. § 1.407, the petitions filed by the Satellite Dealer Forum and K-Sat Broadcasting and by General Instrument Corporation, et. al. are hereby denied.

FEDERAL COMMUNICATIONS COMMISSION

Donna R. Searcy
Secretary

APPENDIX A

Comments/Oppositions:

Oppositions:

ABC Radio Network, Inc. (ABC)
Alascom, Inc. (Alascom)
American Telephone & Telegraph Co. (AT&T)
ARC Professional Services Group, Inc. (ARC)
GE American Communications, Inc. (GE)
GTE Spacenet Corporation (GTE)
Hughes Communications Galaxy, Inc. (Hughes)
IDB Communications Group, Inc. (IDB)
International Family Entertainment, Inc. (IFE)
National Cable Satellite Corporation, d/b/a C-Span (C-Span)
QVC Network, Inc. (QVC)
United States Satellite Broadcasting Company, Inc. (USSB)
Viacom International Inc. (Viacom)
Westwood One, Inc. (Westwood One)

Comments:

CBS Inc. (CBS)
Home Box Office, Inc. (HBO)
National Exchange Satellite, Inc. (NEX)
The Space Segment Group of SBCA (SBCA)
Cascade Cable Systems
North Atlantic Satellite Systems
Cable TV Associates, Inc.

Reply Comments:

Chaparral Communications, Inc. (Chaparral) and Addendum

General Instrument Corporation (GIC)

GTE Spacenet Corporation

Home Box Office, Inc.

Hughes Communications Galaxy, Inc.

National Cable Television Association, Inc. (NCTA)

National Rural Telecommunications Cooperative (NRTC)

Space Systems/Loral (Loral)

Warren Supply Company (Warren)

National Cable Television Cooperative, Inc. (NCTC)

GE American Communications, Inc. Reply to Addendum

Congressional Correspondence:

Honorable Mike Synar

Honorable Rick Boucher

Honorable Jim Cooper

Honorable Billy Tauzin

Honorable Ralph M. Hall

Honorable Jim Slattery

Honorable Bill Richardson

TECHNICAL APPENDIX B

1. Petitioners assert that four foot antennas will produce a picture of acceptable quality under conditions of 3^0 spacing. Based on evaluation of the petitions' proposals, the oppositions, comments and reply comments, we conclude that several crucial technical factors have been omitted in petitioners' analysis. These include the following: 1) the effect of the voltage standing-wave ratio (VSWR) on the carrier-to-thermal noise (C/N) ratio; 2) the C/N expected to be received in the operating environment; 3) the carrier-to-interference plus thermal noise C/(I+N) ratio expected; and 5) the necessity of a higher cost commercial quality low-noise-block-converter (LNB). When these factors are taken into consideration, we conclude that the petitioners' proposals are not feasible.

A. The effect of VSWR on Carrier-to-noise ratio

2. Voltage standing-wave ratio (VSWR) is an electrical phenomenon resulting from the mismatch of the characteristic impedance between the low-noise-block-converter (LNB) and the antenna feed. This electrical phenomenon introduces additional signal loss between the antenna feed and the LNB and, consequently, increases the receiving system noise temperature.

3. As the petitioners assert, due to the rapid commercialization of the high electron mobility transistor (HEMT) in the last few years, it is possible for C-band LNBs to achieve lower noise temperature as low as 25 K, and 40 K LNB is rapidly becoming the new standard. The petitioners further state that a 4 foot antenna having an efficiency of 65% and an antenna temperature of 40 K, with the next generation domestic satellites with equivalent isotropically radiated powers (EIRP's) of 40 dBW, could produce a C/N of 10 dB at home receivers. The petitioners also claim that even currently operating domestic satellites with 5 to 10 watts of transmitter power can produce acceptable video signals for home viewing because a 7 dB of C/N is a minimum value for good quality video reception (FM-receiver-threshold).[65]

4. The petitioners also indicate that a 4 foot HSD system has been operating at Chaparral Communications in San Jose, California and a home installation nearby for over a year. The petitioners further claim that the power levels, antenna parameters, and LNB performance are all measured quantities and the performance is exactly as shown in the analysis.[66] We accept the fact that the systems are performing as claimed. However, the petitioners' analysis fails to take several factors into account in evaluating the HSD operating environment.

5. To evaluate the effect of the LNB upon performance, it is necessary to know how much noise it contributes to the total system noise in the received C/N. Based on our analysis, the LNB used by Chaparral Communications in its operational 4 foot HSD system must be a high quality professional unit with a VSWR range approximately between 1.2:1 to 1.25:1 and an antenna feed VSWR also in the same range. Using these estimates and the parameters identified in paragraph 3 above, the 4 foot receiving antenna gain-to-system noise temperature (G/T) ratio is about 13.6 dB which is identical to the number shown in Figure 2 of Attachment A to the petition. We have recently received technical specifications and cost information from LNB manufacturers and trade journals.[67] These indicate that the unit cost of a high quality professional LNB is several thousand dollars. This information also indicates that a commercial quality LNB with a typical VSWR of 1.3:1 costs approximately $550 and an HSD quality LNB with a typical VSWR of 3.0:1 costs less than $150. The corresponding 4 foot receiving antenna G/T for these two LNBs is 11.6 dB and 9.2 dB, respectively. For a satellite emitting an EIRP of 40 dBW, the received thermal noise video signal C/N for 4 foot antennas using professional, commercial and HSD quality LNBs is 10.0 dB, 8.0 dB, and 5.6 dB, respectively in an interference free environment. It should be noted that a commercial quality LNB could produce barely acceptable video signals because the current C/N for the FM-receiver-threshold level for a good picture is about 7 to 8 dB.[68] For an HSD quality LNB, the received C/N would not allow reception of acceptable video signals for home viewing because a 5.6 dB of C/N is below the FM-receiver-threshold level. Therefore, a 4 foot antenna with an HSD qual-

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[65] Petition at 21 and Attachment at 4-05.

[66] Petition at Attachment and Chaparral reply comments at 6.

[67] LNR Communications, Inc., Locus, Inc., Tampa Microwave Lab, Inc., California Amplifier, In. and Via Satellite. The information obtained from these sources has been made part of the record in this proceeding.

[68] AT&T at 3 footnote. Petition at Attachment 4-05.

ity LNB will not provide reception of a clear video picture with any satellite spacings. Many commenters reach the same conclusion.[69]

B. Carrier-to-noise ratio in the operating environment

6. The petitioners assert that C-band satellite transmitting technology has changed. The next generation of C-band satellites will use amplifiers of up to 16 watts. The petitioners further assert that this power level, coupled with an improved LNB, means that HSD sizes of 4 feet or less will produce a good picture, provided that the antennas can reject interference from adjacent satellites.[70] This assertion is accurate provided that all the petitions' assumptions are true and the EIRP is at least 40 dBW. The petitioners also contend that the next generation domestic satellites will provide acceptable video reception by antennas 4 feet or less "over most of the country." [71] In order to clarify these assertions, we need to look at the expected C-band satellite environment.

7. Based on the technical information that we provided to the IFRB for international coordination purposes[72] and the technical information in the relevant domestic satellite application files, the expected C-band satellite EIRP environment is not as homogeneous as the petitioners claim.[73] Based on our examination, the western arc C-band satellite environment shows that the expected EIRP ranges between 36.2 dBW and 43.0 dBW for different parts of CONUS. The specific expected EIRPs for five domestic satellites in the western arc are illustrated in Attachment 1. These are extracted from the available spacecraft transmitting antenna gain contours and the corresponding maximum video signal peak power into the antenna.

8. The carrier-to-noise ratio is directly proportional to the EIRP from the satellite. Using the petitioner's 4 foot antenna, the commercial quality LNB as described in paragraph 5 and the EIRP from Attachment 1, the expected received video signal C/Ns are illustrated in Attachment 2.[74] The C/N values are for thermal noise conditions without interference from adjacent satellites. The result indicates that only two of the five satellites in the western arc that we analyzed could provide a video signal C/N level of 7 dB and higher for the entire CONUS coverage. The other three satellites provide C/N as low as 4.2 to 6.5 dB in many regions of CONUS. Based on the thermal noise C/N alone, the petitioners' claim of acceptable video performance for 4 foot antennas over most of the country is misplaced because a C/N of 4.2 to 6.5 dB can not enable the reception of a clear video picture.

C. Carrier-to-interference ratio

9. The petitioners claim that HSD sizes of 4 feet or less will produce a good picture, provided that the antenna can reject interference from adjacent satellites.[75] The petitioners state that "[a] 4 foot antenna has a beamwidth of 4.2 degrees. This means that when the 4 foot dish is pointed at the desired satellite, it will also be receiving the full signal from an unwanted satellite spaced 2 degrees away."[76] The petitioners further claim that 3 degree spacing will result in acceptable performance for 4 foot antennas.[77] Many commenters indicate that a 3 degree spacing environment in the western arc will not provide sufficient off-axis discrimination for acceptable performance for 4 foot antennas. [78] Our assessment also indicates that 4 foot antennas will fail to attain the inter-satellite discrimination necessary to produce an interference-free signal for HSD viewing over most of the country. Therefore, the petitioners' claim is misplaced.

10. In a homogeneous video satellite environment, the "carrier-to-interference (C/I) ratio at the receiving earth station is primarily determined by the apparent satellite separation as viewed from the earth, the corresponding receiving antenna off-axis discrimination and the polarization isolation factor. The petitioners indicate that the apparent satellite separation for San Jose, California is 3.4 degrees for satellites separated by 3 degrees in the geostationary-satellite orbit. The corresponding antenna isolation is 11 dB.[79] For the western arc satellites, the apparent satellite separation angle is smaller for other CONUS locations. Earth stations located in New England states, for example, have apparent satellite separation angle of about 3.16 degrees. The corresponding antenna isolation is only 9 dB. The apparent satellite separation angle for other locations is illustrated in the top row of Attachment 3 and the corresponding antenna isolation is illustrated in the second row. Assuming the earth station

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[69] *See e.g.*, comments of GE at 10, GTE at 6.

[70] Petition at 11.

[71] Petition at 21-22.

[72] International coordination is conducted under the auspices of the International Telecommunication Union (ITU) and International Frequency Registration Board (IFRB) which is one of the permanent organs of the ITU with the responsibility to publish the coordination information and to record the coordinated satellite networks in the Master International Frequency Register. Coordination is intended to ensure that the operation of U.S. satellites will be protected from harmful interference by, and will not cause harmful interference to, other countries' satellites. The technical information sent to the IFRB is provided by the licensee pursuant to 47 C.F.R. Section 25.111(b) and conforming to these technical parameters is a condition placed on each spacecraft's authorization.

[73] Petition Attachment at Figure 2; Chaparral reply comments at Attachment.

[74] We concluded earlier that the 4 foot antenna with a HSD quality LNB (*i.e.*, LNB having a VSWR in the range of 3.0:1) will not enable reception of a clear video picture.

[75] Petition at 11.

[76] Petition at 21.

[77] Petition at 21 and Attachment at 4-07-09. Chaparral reply comments at 6.

[78] Comments of GE at 10, comments of GTE at 4, comments of Hughes at 3.

[79] Petition at Attachment 4-08.

antenna has a cross-polarization isolation of 10 dB,[80] the C/I for a single adjacent satellite is between 21 dB and 19 dB. See the fourth row of Attachment 3. The aggregate C/I is between 17.3 dB and 15.3 dB because, in a domestic satellite environment, there are adjacent satellite interference sources from both sides of the satellite. The expected aggregate C/I for the scenario is illustrated in the last row of Attachment 3. There are additional external interference sources that have not been taken into account, *e.g.*, terrestrial fixed-microwave and the 20 MHz offset co-polarized transponders.[81] These factors would further degrade the aggregate C/I.

11. Chaparral in its reply comments indicates that a C/I of 15 dB is considered "[n]early perfect - few noise sparkles - still below cable quality -perfect for home" and a C/I of 18 dB contains "[n]o interference visible at all."[82] Chaparral's experiment verified information provided to the Commission by the satellite industry in 1976.[83] That information indicated that "interference was first detectable with a protection ratio [C/I] of 18 dB, clearly noticeable at 16 dB, and became unacceptable at 14 dB." Therefore, based on this information, a 4 foot antenna will not be able to provide a video picture without any noise sparkles over most of the country since the estimated aggregate C/I is between 17.3 dB and 15.3 dB.

D. Carrier-to-interference plus thermal noise ratio, C/(I+N)

12. As we have demonstrated, a 4 foot antenna with a commercial quality LNB will provide a range of a video C/N between 4.2 dB and 11 dB. We have also demonstrated that the estimated aggregate C/I is between 15.3 dB and 17.3 dB. The composite total C/(I+N) is between 3.9 dB and 10.2 dB.[84] As noted by the petitioners, Chaparral and AT&T, a common FM-receiver-threshold is approximately 7-to-8 dB.[85] This threshold level is the minimum value for a good picture. The composite C/(I+N) for the five satellites is illustrated in Attachment 4. This information demonstrates that there will be many regions in CONUS unable to receive an acceptable video picture using a 4 foot antenna.[86] Furthermore, no single satellite in the scenario could provide acceptable HSD video reception in all regions in CONUS.

E. Cost of an effective system

13. GE's comments state that it received price quotations from a local HSD dealer for C-band equipment.[87] It indicates that the least expensive 10 foot antenna system was approximately $3000 installed and the price of a 4 foot antenna system would be $2700 installed, the $300 difference being attributable to the difference in the cost of antennas alone. Warren Supply Company (Warren) in its reply comments indicates that a 7 foot system costs between $1850 to $2000 and a 4 foot system would cost $200 less. Warren claims that the equipment "savings to consumers based on a $200 per unit savings with 850,000 systems a year, is $170 million dollars.[88] However, in order to make a 4 foot system work in the San Jose area, for example, the HSD quality LNB (a LNB having a VSWR around 3.0:1) needs to be upgraded to a commercial quality LNB (a LNB having a VSWR around 1.3:1).[89] Commission staff has received price quotations from LNB manufacturers and distributors. These do not include installation costs and indicate that a commercial quality LNB is approximately three times as expensive as an HSD quality LNB, a difference of approximately $400. Therefore, the petitioners' claims of lower costs and annual consumer savings possible with 4 foot HSD's appears inaccurate.

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[80] 47 C.F.R. Part 25.209(2b). This rule applies to a transmitting antenna in the 6 GHz band. If a 4 GHz receiving antenna can not meet this standard, the cross-polarization isolation will be less than 10 dB.

[81] Comments of GTE, Appendix A at 1.

[82] Chaparral reply comments at Attachment A.

[83] Declaratory Ruling and Order, RM-2614 and RM-2725, FCC-1169 (released January 7, 1977).

[84] The carrier-to-interference plus thermal noise ratio is the effective aggregate signal level received by an HSD receiver. This ratio determines the quality of the video picture in an adjacent satellite interference environment.

[85] *See* notes 7 and 10.

[86] Acceptable picture implies that the video picture quality is "good" under the FM-threshold condition and there are no noise sparkles under adjacent satellite interference conditions.

[87] GE comments at 42.

[88] Petition at 25. Warren reply comments at 2.

[89] *See* para. 5, *supra*.

ATTACHMENT 1

EXPECTED SATELLITE EIRP FOR VARIOUS PARTS OF CONUS

Orbital Location (deg.WL)	Satellite Name	Pol (1)	Maximum EIRP (2) (dBW)	Approximate EIRP (dBW) in the Region of West Coast	Northern Plane States	New England	East Coast	Southern Florida & Texas
137	Satcom C-1	H	38.2	37.2	36.2	36.2	37.2	36.2
		V	39.0	37.0	38.0	38.0	38.0	37.0
135	Satcom C-4	H	41.5	39.5	39.5	39.5	40.5	39.5
		V	43.0	40.5	39.0	39.0	40.0	40.0
133	Galaxy IR	H	41.1	40.1	39.1	39.1	40.1	39.1
		V	40.5	40.0	38.5	38.5	39.5	38.5
131	Satcom C-3	H	43.0	41.0	41.0	41.0	42.0	41.0
		V	43.0	40.0	39.0	39.0	40.0	40.0
125	Galaxy V-W	H	41.1	39.1	39.1	39.1	40.1	39.1
		V	40.5	39.5	38.5	38.5	39.5	38.5

Note: (1) This is the type of polarization; H stands for horizontal and V stands for vertical.
(2) The maximum EIRP is at the transmitting antenna beam boresight.

ATTACHMENT 2

EXPECTED VIDEO SIGNAL CARRIER-TO-NOISE (C/I) RATIO AT THERMAL NOISE WITHOUT ADJACENT SATELLITE INTERFERENCE

Orbital Location (deg.WL)	Satellite Name	Pol (1)	Maximum C/N (2) (dB)	Approximate C/N (dB) in the Region of: West Coast	Northern Plane States	New England	East Coast	Southern Florida & Texas
137	Satcom C-1	H	6.2	5.2	4.2	4.2	5.2	4.2
		V	7.0	5.0	6.0	6.0	6.0	5.0
135	Satcom C-4	H	9.5	7.5	7.5	7.5	8.5	7.5
		V	11.0	8.5	7.0	7.0	8.0	8.0
133	Galaxy IR	H	9.1	8.1	7.1	7.1	8.1	7.1
		V	8.5	8.0	6.5	6.5	7.5	6.5
131	Satcom C-3	H	11.0	9.0	9.0	9.0	10.0	9.0
		V	11.0	8.0	7.0	7.0	8.0	8.0
125	Galaxy V-W	H	9.1	7.1	7.1	7.1	8.1	7.1
		V	8.5	7.5	6.5	6.5	7.5	6.5

Note: (1) This is the type of polarization; H stands for horizontal and V stands for vertical.
(2) The maximum C/N is at the transmitting antenna beam boresight.

ATTACHMENT 3

ESTIMATED AGGREGATE CARRIER-TO-INTERFERENCE (C/I) RATIO
FOR SATELLITES SPACED AT 3 DEGREES INTERVAL

	West Coast	Northern Plane States	New England	East Coast	Florida
Apparent satellite separation (deg.)	3.37	3.28	3.16	3.2	3.27
Receiving antenna isolation (dB) (1)	11.0	10.0	9.0	9.0	10.0
Assumed cross-polarization isolation (dB)	10.0	10.0	10.0	10.0	10.0
Single-entry C/I ratio (dB)	21.0	20.0	19.0	19.0	20.0
Aggregate C/I ratio (dB)	17.3	16.3	15.3	15.3	16.3

Note: (1) The entry is extrapolated from the Figure in the petition.

ATTACHMENT 4

ESTIMATED COMPOSITE CARRIER-TO-INTERFERENCE PLUS THERMAL NOISE, C/(I+N), RATIO (1)

Satellite Name	Pol (2)	Maximum C/(I=N) (dB)	Estimated Composite C/(I+N) ,dB in the Region of: West Coast	Northern Plane States	New England	East Coast	Florida
Satcom C-1	H	(5.9)	(4.9)	(3.9)	(3.9)	(4.8)	(3.9)
	V	(6.0)	(4.8)	(5.0)	(5.5)	(5.5)	(4.7)
Satcom C-4	H	8.8	7.1	7.0	(6.8)	7.7	7.0
	V	10.1	8.0	(6.5)	(6.4)	7.3	7.4
Galaxy IR	H	8.5	7.6	(6.6)	(6.5)	7.3	(6.6)
	V	8.0	7.5	(6.1)	(6.0)	(6.8)	(6.1)
Satcom C-3	H	10.1	8.4	8.3	8.1	8.9	8.3
	V	10.1	7.5	(6.5)	(6.4)	7.3	7.4
Galaxy V-W	H	8.5	(6.7)	(6.6)	(6.5)	7.3	(6.6)
	V	8.0	7.1	(6.1)	(6.0)	(6.8)	(6.1)

Note: (1) The entry enclosed by a set of parentheses is below a typical FM-receiver-threshold level of 7 db.
(2) This is the type of polarization: H stands for horizontal and V stands for vertical.