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

In the Matter of Application of STARSYS, INC. For Authority to Construct a Low-Earth Orbit Communications Satellite to be Stationed in an Inclined Non-Geostationary Orbit	)	File No. 33-DSS-P-90(24)

REPLY COMMENTS OF ORBITAL COMMUNICATIONS CORPORATION

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September 21, 1990

SUMMARY

In its comments on the Starsys application, ORBCOMM demonstrated that Starsys was not qualified to be a Commission licensee for the proposed low-Earth orbit satellite system. Starsys' response has failed to rebut this showing.

Starsys' 95% ownership by aliens (with a majority being held by the French government) disqualifies Starsys under Section 310 of the Communications Act, notwithstanding Starsys' attempts to evade these limits by unilaterally declaring itself to be a private carrier, and by using an artificial stock voting arrangement.

In addition, the numerous, significant defects in its proposal indicate that Starsys is not technically qualified to construct and operate the proposed satellite system, and Starsys' response does not demonstrate otherwise. Given the current usage of the frequencies being requested by Starsys, the proposed spread spectrum system will suffer from "jamming." In addition, there are no capacity advantages from spread spectrum operation, and the proposed Starsys satellite constellation will provide inadequate coverage due to precession. For all of these reasons, the Commission should promptly dismiss the Starsys application.

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REPLY COMMENTS OF ORBITAL COMMUNICATIONS CORPORATION

Orbital Communications Corporation ("ORBCOMM"), a wholly-owned subsidiary of Orbital Sciences Corporation ("OSC"), by its attorneys, hereby submits its reply to the response of Starsys, Inc. ("Starsys").1/ ORBCOMM is the initial applicant for a commercial, low-Earth orbiting satellite system, having submitted its Application and Petition for Rulemaking more than two months prior to the Starsys filing.2/ As such, ORBCOMM agrees with Starsys and the commenters in this proceeding that

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1/ Reply Comments of Starsys, Inc., filed September 4, 1990 (hereinafter cited as "Starsys Response").

2/ ORBCOMM filed its proposal on February 28, 1990, and the application and rulemaking petition were subsequently put on public notice by the Commission: Orbital Communications Corporation, File No. 22-DSS-MP-90(20), Public Notice Report No. DS-953, April 11, 1990; Orbital Communications Corporation, RM No. 7334, Public Notice Report No. 1814, April 4, 1990.

there is a need for the types of services that can be offered by a low-Earth orbiting satellite system.[3]

ORBCOMM does object, however, to Starsys' attempts to characterize ORBCOMM's proposal as inefficient and anticompetitive. As ORBCOMM stated previously, in submitting its pioneering proposal and request for a spectrum allocation, ORBCOMM did not anticipate or attempt to provide for copycat applications such as Starsys'; ORBCOMM merely requested sufficient spectrum for its own system.[4] Thus, in response to the unjustified criticisms by Starsys, ORBCOMM made explicit that it had no objection to other qualified applicants, so long as they sought other spectrum,[5] or their service would not interfere with the ORBCOMM system.[6] As ORBCOMM demonstrated, however, the Starsys spread spectrum proposal is unworkable and incompatible with the ORBCOMM proposal. Therefore, Starsys' claim that "Orbcomm has refused to amend its application to specify ... spread spectrum modulation techniques" (Starsys Response at p. 2) is misleading and irrelevant.

3/ ORBCOMM does disagree, however, with Starsys' attempts to characterize the views of a single NOAA employee as a government endorsement. Starsys Response at pp. 2 & 4. See Attachment A hereto, explaining that Dr. Laur's views do not represent NOAA.

4/ Reply Comments of Orbital Communications Corporation in RM-7334, May 22, 1990 at pp. 7-9.

5/ We note that the Commission has tentatively identified spectrum in addition to that originally requested by ORBCOMM for allocation to low-Earth orbit services. FCC News Release, Report No. DC-1711, September 19, 1990.

6/ Id.

In its response to ORBCOMM's comments on its application, Starsys attempts to defend its application against ORBCOMM's claims that Starsys is not a qualified applicant. As ORBCOMM demonstrates herein, however, the Starsys Response merely attempts to obfuscate the issues. Shorn of its rhetoric, the Starsys response does not rebut ORBCOMM's showing that Starsys is unqualified to be a Commission licensee.[7/]

I. Starsys Failed to Rebut the Showing that It is Not Legally Qualified to be a Commission Licensee

As indicated by ORBCOMM (and not disputed by Starsys), 95% of the equity of Starsys is owned by aliens, with a majority of that foreign ownership belonging to the French government.[8/]

7/ There is also no merit to Starsys' claim that the ORBCOMM Comments should be disregarded because they were not accompanied by an affidavit. The Communications Act allows the Commission to take official notice of information, and the "facts" relied on by ORBCOMM were taken from the Starsys application and other filings by Starsys to governmental entities (e.g., the Starsys submission to the NTIA chaired CCIR Study Group IWP 8/14). Presumably ORBCOMM can have the Commission take notice of the information in the Starsys filings, despite Starsys' recent attempts to disclaim that information (e.g., Starsys Response Appendix B at p. 1: "The examples quoted by Orbcomm used the extremely conservative numbers generated by STARSYS for a committee document, and were never intended to represent a 'real world' situation.") Moreover, there is no dispute as to the salient facts, Starsys merely contests the implications of those facts (e.g., Starsys does not dispute the indirect ownership of Starsys by the French government, but does disagree as to the impact of such ownership under the Communications Act). Thus the Commission has an adequate record on which to base a dismissal of the Starsys application.

8/ Starsys is 95% owned by North American CLS, in turn a wholly-owned subsidiary of the French company Collecte Localisation Satellites, which is owned 55% by CNES (the French (continued...)

Under Section 310 of the Communications Act, there are limits on foreign ownership of FCC common carrier licensees,[9] and prohibitions against any FCC licenses being granted to a foreign government or a representative of a foreign government.[10] Starsys attempts to evade these limitations (notwithstanding its 95% alien ownership) by (i) declaring itself to be a private carrier, and (ii) creating an artificial two-tier stock ownership such that the 5% minority shareholder can elect three of the five members of the Board of Directors. In its comments on the Starsys application, ORBCOMM observed that Starsys' unilateral attempt to declare itself a private carrier so as to avoid the limits on foreign ownership of Section 310 was invalid and inconsistent with Commission and judicial precedent. ORBCOMM also observed that the 95% shareholder retained the ability to control the corporation.

With respect to whether Starsys will be a private carrier, the Starsys Response argues that because the Commission allows private carrier sales of domestic satellite transponders, Starsys likewise is under no obligation to provide service on a common carrier basis.[11] Starsys' argument is unavailing. As

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8/ (...continued)
Space Agency), 15% by INFREMER (the French Institute for Research of the Sea) and 30% by French banks.

9/ 47 U.S.C. § 310(b).

10/ 47 U.S.C. § 310(a).

11/ Questions also remain as to whether Starsys' proposed operations as set forth in its application are in fact consistent with its claims that it will operate as a private carrier.
(continued...)

an initial matter, with respect to the transponder sales decisions, the FCC undertook an extensive analysis of whether, under the circumstances presented there, private carriage was in the public interest;[12] the FCC did not determine that all satellite services can be offered under private carriage. Thus, the decision as to whether there is a "legal compulsion" to provide the type of low-Earth orbit satellite services at issue here as a common carrier is one for the Commission to make, not Starsys. Starsys has not shown how in this case the public interest (as opposed to its own private interest in avoiding the limitations of Section 310(b) of the Communications Act) would be furthered by operating as a private carrier.[13]

11/ (...continued)
Rather than resolving the discrepancies between its assertion that it will only provide satellite capacity in million transmission units ("MTUs") and its description of the end-to-end services that will be offered, the Starsys Response indicates that in some cases it may offer "additional capacity to a municipality or a hospital (or anyone else) who may have a need for 'emergency capacity' in excess of the amount initially contracted for". Starsys Response at p. 18.

12/ See e.g., Wold Communications, Inc. v. FCC, 735 F.2d 1465, 1471 (D.C. Cir. 1984) ("The crucial question this case posed for the Commission was not whether satellite operators engaging in transponder sales would be acting as common carriers; instead the FCC's prime task was to determine whether authorization for the proposed noncommon carrier service promised sufficient public benefits to justify the assignment of scarce orbital locations and frequencies.").

13/ The lone argument advanced by Starsys concerns its ability to customize service. However, as experience with nondominant common carrier regulation illustrates, common carriage is not inconsistent with customized offerings that meet the particular needs of customers. Moreover, given inter alia the public safety nature of the services touted by Starsys in its application, leaving the availability of such services wholly to the private, commercial discretion of Starsys would not be consistent with the
(continued...)

In addition, Starsys' proposed bulk sales of low-Earth orbit satellite service in MTUs is economically and operationally distinguishable from the sale of discrete transponder capacity, rendering the transponder sales decisions of limited precedential value.[14/] Moreover, it is ludicrous for Starsys to respond that there will be adequate capacity available on a common carrier basis because ORBCOMM proposes to operate as a common carrier, when the FCC has not yet licensed any carriers for this service.[15/] In sum, Starsys' reliance on the transponder sales decisions to establish that it may (and intends to) operate as a private carrier is misplaced. Thus, the limitations of Section 310(b) should serve to disqualify Starsys as a licensee in light of the 95% ownership by aliens.

13/ (...continued)
public interest. Cf., Amendment of Parts 0, 1, 2 and 95 of the Commission's Rules regarding the Establishment of a Personal Emergency Locator Transmitter Service, PR Docket No. 89-599, FCC 89-342, released December 20, 1989 (eligibility for licensing of PELTS base stations proposed to be limited to governments and private organizations recognized by government entities to perform search and rescue functions).

14/ For example, instead of acquiring discrete capacity that the purchaser can control and use flexibly from its own earth station, the Starsys MTUs would have to transit the Starsys ground station and be subject to Starsys' control in order to ensure the operational integrity of the system. Likewise, the purchaser of MTUs cannot depreciate its investment and otherwise take advantage of its ownership. Indeed, ORBCOMM questions whether there will be any demand for MTUs. None of the commenting parties that endorsed the Starsys proposal expressed any interest in acquiring MTUs for resale, nor did they indicate the need for such a vast amount of capacity for their own use.

15/ Starsys Response at p. 17. Moreover, the technical incompatibility of Starsys' proposal with the low-Earth orbit service proposed by ORBCOMM negates this argument.

Starsys also fails to satisfactorily respond to ORBCOMM's demonstration that the indirect, majority ownership by the French government renders Starsys unqualified under Section 310(a) of the Communications Act. In order to demonstrate "control" by the minority shareholder, Starsys relies solely on a provision of the by-laws (which were not part of its application) to establish that three of the five members of the Board of Directors will be elected by the 5% minority shareholder. However, given the ability of the 95% shareholder to control all shareholder votes (except electing the Board of Directors), it would appear that the French parents continue to have de jure control as well as ownership.[16/]

16/ See e.g., Committee for Full Value of Storer, Inc., 57 RR 2d 1651 (1985)(no substantial change of control in a proxy fight, because the shareholders retain ultimate and legal control); Peoria Community B/casters, Inc., 47 RR 2d 1463, 1468 (1980)("even a majority stockholder is frequently content to let others take a major role in management, but it would hardly be suggested that a majority stock interest is not a controlling interest merely because it has, as a matter of policy, refrained from exercising this control," citing Paramount Television Productions, Inc., 17 FCC 264 (1953).). Cf., Continental Cellular, 1 FCC Rcd. 15 (1986)(FCC cannot waive the foreign ownership limitations of Section 310(b) even if a contract insulates the corporate officers or directors); Citizenship Rights of Section 310, 58 RR 2d 531, 537 (1985)(the FCC cannot waive the limits of §310(b) even if the existence of "a 'single majority stockholder' or some other factor negated the potential for control or influence by that alien"); FTC Communications, Inc., DA 89-813, released July 13, 1989 ("the Commission concluded that for purposes of the international competitive carrier policies a foreign-owned carrier would be defined as a carrier that is over 15 percent directly or indirectly owned by a foreign telecommunications entity or on whose board of directors an employee, agent or representative of a foreign telecommunications entity sits").

In addition, the dominant foreign ownership[17/] would appear to raise de facto control issues.[18/] Starsys fails to address the de facto foreign control issues, asserting merely that the by-laws limitation will prevent any control by the 95% shareholder. Indeed, even more questions regarding the apparently direct involvement of the French government are raised by the comments submitted by one of the parties endorsing the Starsys proposal (and cited with approval by Starsys): "My relationship with Starsys started when the French Trade Commission contacted me and asked me to review the program."[19/]

Starsys' reliance on the Commission's recent Orion decision[20/] to alleviate these foreign ownership and control concerns is misplaced. That situation is readily distinguishable: (i) Orion was seeking a license for an

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17/ Presumably the vast majority of financing has also been provided by the 95% French owners, although the record is void of any information on financing, other than the fact that according to restated Certificate of Incorporation, "The corporation has not yet received any payment for any of its stock."

18/ See e.g., Arnold L. Chase, 5 FCC Rcd 1642 (1990)(a hearing was necessary as to whether the applicant actually had control because of, inter alia, financial control by the applicants father); Pan Pacific Television, Inc., 65 RR 2d 863 (1988)(financing is an indicia of de facto control; other factors may also be considered, rendering a hearing necessary); Channel 31 Inc., 45 RR 2d 420 (1979)(control of finances is "one of the most powerful and effective methods of control of any business"). Cf., International Competitive Carrier, 102 FCC 2d 812 (1985), recon. denied 60 RR 2d 1435 (1986)(a 15% ownership share by a foreign telecommunications entity bestows sufficient control to classify the carrier as "dominant").

19/ Comments of English Automotive, Ltd, August 10, 1990 at p. 1.

20/ Orion Satellite Corporation, File No. CSS-83-002-P-(M), FCC 90-241, released August 6, 1990.

international separate satellite system, which both mandates private carriage and raises different policy interests that may be benefitted by foreign ownership[21/]; (ii) Orion will be strictly insulating the foreign investors from any management or control through the use of a limited partnership structure (which was further modified to meet the Commission's concerns), whereas Starsys simply proposes to limit nominally the ability of the 95% shareholder to elect a majority of the Board of Directors[22/]; (iii) Orion has represented that there will be no foreign government or PTT limited partner investors (and Orion is required to give the FCC the opportunity to review new investors),[23/] whereas the majority of the stock of the 95% shareholder of Starsys is owned by a French government agency. Finally, as the concurring statement of Commissioner Barrett makes clear, foreign investment was not "irrelevant" as Starsys asserts (Starsys Response at p. 23), but rather:

> the Commission reviews the implications of separate systems foreign investment on a case-by-case basis. To the extent the Commission conducts such a case-by-case review, I believe we should consult other governmental agencies early in the review process. Where separate systems applications involve foreign investment, I believe such

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21/ Starsys reiterates that it has filed a domestic satellite system application. Starsys Response at p. 9.

22/ Indeed, the Orion arrangement prevents the limited partners from even communicating with the general partner, whereas Starsys proposes to rely on the experience and expertise of its French affiliates.

23/ Letter from Thomas J. Keller to Richard M. Firestone, May 3, 1990 at fn. 8.

applications raise potential international political, economic and security concerns.

Starsys clearly was aware of (and concerned with) the limits of Section 310 of the Communications Act, and its self-declared private carrier operations and spurious stock voting rights structure are little more than an obvious attempt to evade those proscriptions. The Commission should reject these artifices.

II. Starsys Failed to Rebut the Showing that It Is Not Technically Qualified to be a Commission Licensee

In its comments on the Starsys application, ORBCOMM demonstrated that the proposed Starsys system will be unworkable and inefficient, thus calling into question Starsys' technical qualifications to construct and operate the low-Earth orbit satellite system.[24] Starsys' response to the technical qualifications issue is two-fold: it challenges ORBCOMM's technical analyses, and it asserts that the defects identified by

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24/ ORBCOMM had also raised questions concerning Starsys' financial qualifications, because there was a virtual absence of any financial information. Starsys asserts that it provided the information called for under a lax standard (citing to the authorization of Omninet), but Starsys did not even include that minimal amount of information in its application, since it failed to include "letters from three banks which 'indicated their interest in arranging financing for the system.'" (Starsys Response at p. 29; ORBCOMM also contends that the proffered standard is too lax, as the subsequent history of Omninet illustrates.) Starsys additionally contends that the Commission's July 16th Public Notice "limits the application of Appendix B to technical matters." Starsys Response at pp. 30-31. The Commission's Public Notice speaks for itself, but Starsys' interpretation is simply not credible. At any rate, ORBCOMM does not believe that any further response on this issue is necessary at this time.

ORBCOMM, even if true, are "minor in nature." With respect to the former claim, Starsys has failed to demonstrate that its proposed system will be workable in the frequencies being sought. With respect to the latter claim, ORBCOMM disagrees with Starsys' belief that design defects that will make the system unworkable can properly be characterized as "trivial." (Starsys Response at p. 26)

As an initial matter, ORBCOMM had difficulty attempting to analyze the technical characteristics of the Starsys proposal because of the absence of information, and the practice of Starsys of changing or disavowing what information it has provided. For example, ORBCOMM relied on Starsys' filing with the NTIA chaired U.S. CCIR Study Group 8/14 to determine some of the values for the Starsys system, because Starsys failed to include that information in its application. Starsys then disowned those values, asserting that they were "extremely conservative numbers generated by STARSYS for a committee document, and were never intended to represent a 'real world' situation." (Starsys Response, Appendix B at p. 1)[25/]

Likewise, despite the assertion in the application that Starsys will employ polling,[26/] Starsys now claims that their

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25/ In proposing that the United States rely upon these data for developing a position for submission to the CCIR in connection with preparations for the forthcoming WARC, it is not clear what Starsys' calculations were "intended to represent," if not a "real world" situation.

26/ The Starsys application at p. VII-2 indicated:

(continued...)

application was "misinterpreted," and only limited versions of the user terminals will be polled.[27/] Similarly, despite the indication in the application that the Starsys user terminals would employ a whip antenna (Starsys Application at pp. VII 52-54), Starsys now claims that the terminals will use an antenna that "would favor the vertical elevation angle." (Starsys Rulemaking Reply at p. 10). Starsys additionally has provided inconsistent information with regard to its proposed satellite constellation[28/] and link margins.[29/]

26/(...continued)

> The communication path starts with the OUTBOUND interrogation transmissions. These OUTBOUND transmissions provide time synchronization and query of each addressed user terminal to see if it requires a position determination or data.

27/ Starsys Response, Appendix C. Apparently Geostar made the same "misinterpretation" as ORBCOMM in its analysis of the Starsys system capacity. ORBCOMM further observes that Starsys failed to address several of the technical questions Geostar raised with respect to the proposed spread spectrum system, e.g., Geostar Comments at footnotes 10 and 12, and associated text.

28/ In its application, Starsys refers to a "randomly distributed constellation" (p. VII-16), whereas in the Starsys Response it now asserts that "clearly the satellites launched later must be more carefully placed to avoid gaps in coverage." Starsys Response, Appendix C. But see pp. 17-18, infra, concerning the precession problem regardless of the subsequent "careful placement."

29/ The Starsys application indicates 3 dB of margin on the link to the mobile units (p. VII-9), while 13 dB is indicated in the Starsys Response at Appendix B, p. A-5.

A. Starsys Has Failed to Demonstrate That Spread Spectrum Will Be Workable or Practical in These Bands

Despite Starsys' continued use of "spread spectrum" as a talisman, the FCC should not be left with the impression that there are any advantages to the use of spread spectrum modulation for the proposed low-Earth orbit satellite service in the selected VHF bands. The characteristics and number of existing users, while downplayed by Starsys in its reply comments, will prevent Starsys' spread spectrum modulation technique from operating in these frequencies. Additionally, even if the interference problem somehow could be solved,[30/] the use of spread spectrum modulation would not allow more low-Earth orbit satellite service users to share the same spectrum as compared to narrowband modulation.

1. Jamming

In its comments on the Starsys application and rulemaking petition, ORBCOMM pointed out that the characteristics of the existing usage of the 148.0-149.9 fixed and mobile band would lead to nearly continuous jamming of the Starsys system.[31/] Starsys provided two responses: an unsupported assertion that there will be no jamming; and a factual report of

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30/ ORBCOMM is not aware of any current technology that would provide a solution, and no other interested party has come forth with a workable solution.

31/ It should also be noted that because the Starsys ground stations and the user terminals share a common uplink in the 148-149 MHz band, communication in both directions would be impossible under "jammed" conditions.

the conditions under which the Starsys spread spectrum system would be "jammed."

While the disagreement in the implications of the technical analyses between ORBCOMM and Starsys is not unexpected, the level of agreement that can be found in the technical submissions of each party is noteworthy. ORBCOMM indicated that, based upon information available in the Starsys application, simultaneous transmission of two 50 watt base stations would cause the spread spectrum system to be jammed. Starsys responded with an indication that the correct number was five such stations (Starsys Response at A-7), an insignificant difference considering the large number of U.S. base station assignments in the band being requested. Additionally, Starsys claims that a fast Fourier transform (FFT) based pre-processing algorithm could increase to ten the number of carriers of any arbitrarily high power level that could be tolerated (Starsys Response, Appendix B at p. 6). With over 1500 base stations authorized to operate in the 1 MHz portion of the band proposed by Starsys, the technical statements made by each firm arrive at virtually the same conclusion with respect to jamming probabilities: it takes less than one percent of the assigned base stations transmitting to render communications impossible. The resulting unavailability of Starsys' system is incompatible with the reliability requirements of the emergency and messaging services that Starsys proposes to offer.

There are several aspects of the utilization in the proposed bands that the Commission should consider when evaluating Starsys' proposal to use spread spectrum modulation and the potential for jamming:

(a) Of the 3900 recorded authorizations in the band, over 3000 are for fixed and mobile networks with at least one base station and many lower power remotes. ORBCOMM understands that well in excess of 40,000 mobiles are in service. At least 10,000 helicopters are reported to have mobile equipment installed. While government spectrum usage is believed to be moderate relative to typical non-governmental usage, even a tiny fraction of use will result in jamming of the Starsys system.

(b) Base station transmitter power output is typically 50 watts with antenna gains averaging on the order of 10 dBi. Additionally, there are at least 200 assignments to transmitters with power in excess of 100 watts.

(c) While Starsys contends that base station antenna discrimination will reduce the aggregate level of interfering power well below the sum of the active transmitter power levels, it is not realistic to assume all transmitters will be so attenuated. From a 1300 km orbit, 70% of the time that the satellite is in view of a ground based transmitter it is at an elevation angle of 25 degrees or less, and 30% of the time at 10 degrees or less. Additionally, a satellite near the horizon of a base station transmitter will pass through the main lobe of at least 10 dB of gain, thus eliminating the advantage gained from attenuating all other visible interferers.

Given this background, it is virtually certain that the proposed Starsys system will be jammed a significant portion of the time.

2. <u>Capacity</u>

Starsys has also failed to rebut ORBCOMM's showing that there would be no capacity advantage from use of spread spectrum. In responding to the issue of relative capacity of spread spectrum versus FDMA, Starsys changed the basis of the comparison put forward by ORBCOMM. The calculations made by ORBCOMM were for the 137.0-138.0 MHz downlink. Starsys' statement, "FDMA uplink capacity is not 375,000 bits/second, but instead is 288,000 bits/second . . . . ORBCOMM's calculation is in error" (emphasis added)(Starsys Rulemaking Reply Comments at p. 11) is thus misleading. The ORBCOMM calculation was not for the uplink, but rather the downlink. ORBCOMM believes that this is the only link that may have an interference environment suitable for spread spectrum, so that it is the proper basis for comparison. ORBCOMM thus stands behind the 375 kbps capacity figure.[32/]

In seeking to bolster its response, Starsys arbitrarily (and without explanation or even acknowledgement that it was doing so) changed several inputs to the spread spectrum capacity formulation.[33/] Such substitution of values will obviously change the predicted capacity. Three alternative calculations of Starsys' spread spectrum capacity can be produced, depending on the thermal noise margin selected: (i) using the 3 dB thermal noise margin quoted in the Starsys application produces a value of 177 kbps; (ii) using the 7.5 dB thermal noise margin (calculated by ORBCOMM from a 12.7 dBw EIRP and identical link

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32/ It is true that FDMA capacity will be somewhat lower for the return link, due to increased allowance per channel for mobile transmitter instability and the lower data rate per channel. However, this lower FDMA downlink capacity should be compared to a much lower effective capacity for the Starsys system, because such a spread spectrum system will be subject to jamming in the downlink direction in the frequencies being sought by Starsys.

33/ The primary factors which determine the multiple access capability of a spread spectrum system are the occupied bandwidth and the carrier to noise margin before interference allowance. Starsys used significantly different thermal noise margin values in its response, without providing any basis for the new values.

parameters to that used in the ORBCOMM application) produces the value of 185 kbps which was included in ORBCOMM's comments on the Starsys proposal; and (iii) using the 20.1 dB thermal noise margin quoted by Starsys in its reply comments yields the 583 kbps figure included in its reply.

Starsys' arbitrary increase in signal margin from 3 dB to 20 dB was not justified or explained, and appears to have been altered merely to support spurious claims concerning the spectral efficiency of the proposed spread spectrum modulation technique. The increase in margin of 12.5 dB (a more than 17 fold increase) over the prudent calculations made by ORBCOMM raises further question about the technical qualifications of Starsys to plan and construct an efficient and reliable communications system to serve millions of subscribers.[34/]

B. Starsys Has Failed to Demonstrate That the Proposed Satellite Constellation Will Provide Adequate Coverage

Starsys' response on the issue of orbit selection and stationkeeping requirements demonstrates a fundamental lack of understanding of the realities of launch vehicle procurement and the constraints imposed by orbital mechanics. The Commission should consider the following flaws in the Starsys proposal when evaluating the technical qualifications of Starsys to construct and operate a low-Earth orbiting satellite system:

34/ The 12.5 dB comes almost entirely from the allocation of receiver noise. The Starsys figure is totally inconsistent with the electromagnetic background noise at these frequencies, as well as with low cost receiver front ends.

(a) The satellite concept presented in the application has no orbital trim or stationkeeping capability, which will result in a random distribution of satellites, in turn adversely affecting system availability. Even if Starsys achieves the +/- 20 nmi orbital injection, the satellites will suffer from precession (which will not occur uniformly).[35/] In addition, it is unlikely that Starsys will be able to achieve the +/- 20 nmi orbital injection without trim for most of the launch possibilities listed at page VII-19 in the application, further exacerbating the problem.

(b) With respect to Starsys' assertion that "the satellites launched later [will be] more carefully placed to avoid gaps", ORBCOMM observes that this "fix" will only avoid gaps at the time the subsequent satellites are launched. The +/- 20 nmi orbital altitude dispersion value incorporated in the Starsys application will lead to a differential drift rate of some 22 degrees per day. Thus, rather than a "small drift of the entire constellation," (Reply Comments, Technical Statement at 1), major changes in the orientation of the constellation will occur on a daily basis, and result in significant gaps in coverage.

In sum, Starsys' proposal evidences a lack of understanding of the orbital mechanics of low-Earth orbit operations.[36/]

35/ The experience of the U.S. Navy Transit satellite system is instructive, where such irregular precession has been observed. See "Navy Navigation Satellite System Status", R.J. Danchik & L.L. Pryor, presented at The Royal Institute of Navigation (London, England, October 17-19, 1989) at Figure 7 (Attachment B, hereto).

36/ As an further matter, Starsys' recent pronouncements with regard to the user antennas raise questions concerning its technical competence. Starsys' suggestion in its August 17th response that Starsys user terminals would use an antenna that "would favor the vertical elevation angle" (Starsys Rulemaking Reply Comments at pp. 10 & 13) is not only inconsistent with representations made in the Starsys application, but also indicates that Starsys harbors a fundamental misunderstanding of the technical aspects of low-Earth orbit satellite systems. The vast majority of opportunities to communicate with a satellite in a 1300 km orbit are at low look angles -- 70% of those opportunities will be below 25 degrees. Thus, an antenna favoring the vertical elevation angle would decrease performance
(continued...)

CONCLUSION

In its comments on the Starsys application, ORBCOMM demonstrated that Starsys was not qualified to be a Commission licensee for the proposed low-Earth orbit satellite system. Starsys' response has not shown otherwise. Starsys' 95% ownership by aliens (and majority ownership by the French government) disqualifies Starsys under Section 310 of the Communications Act, notwithstanding Starsys' attempts to evade these limits by unilaterally declaring itself to be a private carrier, and by using an artificial stock voting arrangement. In addition, the numerous, significant defects in its proposal demonstrate that Starsys is not technically qualified to construct and operate the proposed satellite system. Therefore, the Commission should promptly dismiss the Starsys application.

Respectfully submitted,

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36/(...continued)
the vast majority of time. In addition, ORBCOMM believes, based on extensive discussions with potential customers, that the automotive market will not tolerate an additional external antenna when a single radio antenna can serve both the satellite service and the FM radio needs.

ENGINEERING CERTIFICATE

The undersigned hereby certifies that he is the technically qualified person responsible for the preparation of the engineering information contained in the foregoing Reply Comments of Orbital Communications Corporation, and that he has prepared the foregoing technical information. Further, he certifies, under penalty of perjury, the technical information is complete and accurate to the best of his knowledge.

David C. Schoen

David Schoen
Engineer
Orbital Communications
Corporation

September 21, 1990

<u>DECLARATION</u>

I, Alan L. Parker, President of Orbital Communications Corporation, hereby declare under penalty of perjury that I have reviewed the foregoing Reply Comments of Orbital Communications Corporation and have found it to be true and correct to the best of my belief.

Executed on September 21, 1990.

Alan L. Parker
President
Orbital Communications
Corporation

CERTIFICATE OF SERVICE

I, Laura E. Magner hereby certify that on the 21st day of September, 1990, a true copy of the foregoing Reply Comments of Orbital Communications Corporation was mailed, postage prepaid, to the parties on the attached service list.

Laura E. Magner

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ATTACHMENT A

PUBLIC REFERENCE COPY

UNITED STATES DEPARTMENT OF COMMERCE
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OFFICE OF THE GENERAL COUNSEL

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September 17, 1990

Donna R. Searcy
Federal Communications Commission
1919 M Street, N.W.
Washington, D.C. 20005

File No. 33-DSS-P-90(24)

Dear Ms. Searcy:

This letter concerns a letter Dr. Michael Laurs sent to the FCC on August 16. The letter expressed Dr. Laurs' opinion that the FCC should grant an application by STARSYS, Inc., to build a Low Orbit Communication Mobile Satellite System.

Although written on letterhead of the Southwest Fisheries Science Center, the letter does not represent an official position of the National Marine Fisheries Service. The letter was not reviewed by anyone else in NMFS and should be read only as Dr. Laurs' personal views.

Sincerely yours,

Margaret Frailey Hayes

Margaret Frailey Hayes
Assistant General Counsel
for Fisheries

cc: DGC - James W. Brennan
F/SWC - Richard Neal
Steven Goodman

NAVY NAVIGATION SATELLITE SYSTEM STATUS

Robert J. Danchik
L. L. Pryor
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Presented at
The Royal Institute of Navigation

NAV 89
London, England
October 17 - October 19, 1989

The Navy Navigation Satellite System (NNSS), also known as TRANSIT, provides a global system for navigation, surveying, and time distribution. The TRANSIT System is widely used by the U. S. Navy and the industrial world as a worldwide, highly reliable, precise all-weather navigation/survey system. Currently, there are 12 spacecraft in the constellation. Three of these spacecraft are of the newer NOVA design, and nine are of the older OSCAR design. Three NOVA and four OSCAR Spacecraft are operational. Five OSCAR Spacecraft are being stored in orbit. In this paper, we will review the current status and future of the TRANSIT System.

1.0 SYSTEM OVERVIEW

The TRANSIT System was invented in 1957 by the late Dr. F. T. McClure to provide precision periodic position fixes for the U. S. Navy at sea. In the early days, JHU/APL was the Design Agent for all aspects of the System (i.e., Spacecraft User Equipment and Ground Control System). Today, JHU/APL is the Technical Agent to the U. S. Navy. GE/ASTRO was the Spacecraft Production Contractor. Westinghouse, Magnavox, ITT, and AMEX have supplied user equipment to the U. S. Navy. Overall management of the system is provided by the U. S. Navy Strategic Systems Programs (SSP). The Navy Astronautics Group maintains and operates the spacecraft in orbit. A simplified concept of the TRANSIT Doppler Navigation is shown in Figure 1. The system consists of spacecraft in a nominal 600 nautical mile orbit, four ground control stations, and unlimited numbers of users. Only one spacecraft is required to provide full system precision. Navigation fix availability improves as the number of spacecraft in orbit increases. We will address this later.

2.0 CONSTELLATION

There are three types of spacecraft in the constellation. They are designated as OSCAR, SOOS, and NOVA Spacecraft. Figure 2 provides an artist concept of the OSCAR and NOVA Spacecraft in orbit. The NOVA is in the foreground; the OSCAR is in the background. The SOOS Spacecraft are modified OSCAR Spacecraft that were launched two at a time on a Scout launch vehicle. An artist concept of the SOOS is shown in Figure 3. The spacecraft in the foreground is surrounded by a cradle that supports the upper spacecraft in the launch configuration. Figure 4 provides the summary characteristics of the spacecraft.

Figure 5 provides the current list of spacecraft in orbit. The operational and stored in orbit spacecraft are as designated in the figure. The plan is to actively manage the spacecraft in orbit, maintaining up to seven operational spacecraft at any one time and providing frequent navigational fix opportunities. The satellites are all in near-circular, polar orbit planes at approximately 1100 kilometers altitude. A view of the constellation from above the North Pole (Figure 6) provides a pictorial reference of global distribution.

The three NOVA Spacecraft form the basic constellation.

Because the OSCAR Spacecraft have a long lifetime (14 years demonstrated in orbit) and the orbit planes precess, the constellation view will change with time. Figure 7 shows how the orbit planes of the spacecraft precess across each other with time. This precession is due to the launch accuracy of the SCOUT Rocket and is not a program concern. In order to maintain good earth coverage, the Designated Operational Satellite Numbers change with time. In January, OSCAR 13 failed in orbit. This failure occurred after 21 years and eight months of operation. Since housekeeping telemetry had failed several years ago, we could not determine the precise cause of failure; however, the characteristics observed indicate that a battery failure may have occurred. OSCAR 20 has been in service for 15 years.

Another Spacecraft Management area is the precision prediction of spacecraft position in low earth orbit. The largest uncertainty with prediction of satellite position is the unpredictable variability in air drag on the spacecraft. This uncertainty is magnified during periods of high solar activity such as the next two to three year period that we are just entering. Figure 5 shows how the solar index and magnetic index vary over a short period of time. During the last 11 year solar cycle, we had to take OSCAR 20 out of service for a day or two on several occasions. We expect the same to occur again as we reach the peak of the current cycle. In fact, after the large solar storm in mid March, we took OSCAR 20 out of service for about six days and the other OSCARS out of service for about one day. The NOVA Spacecraft were designed to take out this environmental effect. The subsystem on the NOVA Spacecraft that corrects for air drag is called the Disturbance Compensation System (DISCOS). Figure 9 is a measure of OSCAR drag tracking compared to NOVA drag tracking.

3.0 DISCOS

DISCOS was put on the NOVA Spacecraft to correct for small orbit altitude (period) insertion errors and to correct for the uncertainties of orbit prediction caused by uncertainties in air drag. Since the launch of NOVA 1 in 1981, the subsystem has proven that it can effectively accomplish these corrections. The spacecraft has shown the ability to fly to a prescribed orbit. The orbit precession chart (Figure 7) provides some insight on the initial positioning of the NOVA Spacecraft. The concept of a NOVA launch is to use the Scout launch vehicle to place the spacecraft into a nominal 200 by 500 nautical mile orbit, then to use the on-board Orbit Adjust Transfer System with its five (5) pound thrust to raise the orbit, circularize the orbit, correct for inclination errors, and to place the spacecraft into the nominal orbit period. After achieving orbit, the fuel (hydrazine) is dumped. The DISCOS teflon thruster engines are then used to fly to the precision orbit and to take out the prediction errors caused by variable air drag and solar pressure.

We did experience some on-board self-generated (EMI) Electromagnetic Interference on NOVA I after launch. After considerable analysis, a few modifications were made to reduce the energy coming from the source, the electric teflon thruster engines, and to better isolate the subsystems that were experiencing some indications of EMI conditions. These modifications were made largely by using techniques used in good high radio frequency practices (i.e., short ground runs separation of signal and power lines, twisted shielded pairs, etc.) More details are available in a paper given at the Propulsion System Conference in Monterey, California, this past July 10-12, 1989.

Immediately after launch, the DISCOS releases gasses into the vacuum of space. This outgassing continues until the absorbed gasses are depleted from the device. The flow of gasses against the proof mass creates measurable force bias which gradually degenerates.

The following figures describe the DISCOS concept. Figure 10 shows a spacecraft with a proof mass at the center of mass of the spacecraft. The proof mass is not attached to the spacecraft. When we place this spacecraft in orbit, the proof mass will fly a true gravity trajectory, assuming we have corrected for any local bias forces and assuming that we fire some type of thruster to position the spacecraft about the proof mass. Figure 11 is a block diagram of the system.

In the NOVA Spacecraft, we have a DISCOS sensor shown in Figure 12. The proof mass is a hollow cylinder of pure silver that is suspended over a wire by an eddy current. Longitudinal position of the proof mass is sensed by an optical sensing system. Two thruster engines like the one shown in Figure 13 provide the thrust necessary to keep the proof mass within a 20 millimeter band.

Characteristics of the thruster are shown in Figure 14.

Figure 15 shows the degradation of a force bias on the spacecraft due to outgassing after the launch. Figure 16 shows the force bias variation after the initial outgassing.

4.0 USERS

The number of system users continues to expand but at a slower rate and, in particular, at the low cost end of the spectrum, where single channel receivers are sold at prices beginning at about $1,000. The last survey indicated that over 80,000 receivers have been manufactured to date.

We are not familiar with how the single channel receivers are implemented, however, it should be noted that users with single channel receivers may see larger than usual navigation errors during periods of large solar storms. This is independent of the spacecraft position error that NAVASTROGRU will be managing, although the largest error source is caused by the same solar activity. This error is caused by an apparent change in the distance between the satellite and the user caused by the disturbance to the ionosphere. In order to reduce this error, the spacecraft broadcasts the average daily S number which is a measure of the solar activity. An algorithm to provide an error correction was published during the last peak solar cycle.

Two frequency receivers should not see an increase in the navigated position error because the two frequencies provide for good ionospheric error correction. Figure 17 shows the nominal coverage the system will provide to users over the life of the program. Figure 18 provides the nominal percentage of time that a navigator would have to wait over eight hours for a navigation fix opportunity.

Over the past five years to ten years, industry has been meeting the challenge for relatively inexpensive receivers; there has been a significant increase in the number of pleasure craft using the system.

5.0 GEODETIC REFERENCE SYSTEM

Since the initial Geodetic work in the early 1960's, the TRANSIT System has constrained the tracking station coordinates to be consistent whenever a new geodetic model was introduced.

In January 1989, the system changed to the WGS-84 Reference System. The change in order of longitude was 20 meters at the equator and became less with the geometric sine of the latitude toward the poles. Discussion of this topic is beyond the scope of this paper. Those interested should refer to two papers presented at the Fourth International Geodetic Symposium on Satellite Positioning held at the University of Texas at Austin, April 28 - May 2, 1986. The first paper is "World Geodetic System 1984" by B. Louis Decker, Defense Mapping Agency, Aerospace Center, St. Louis, Missouri. The second paper, "Testing of the World Geodetic System - 1984 In Precise Orbit Determination and Point Positioning" by James P. Cunningham, Carol Malyevac, and Robert Whitsell of the Naval Surface Weapons Center, Dahlgren, Va., and Stephen Malp of the Defense Mapping Agency (HTC), Washington, D. C.

Another reference is report number DMA TR 8350.2 prepared by the DMA WGS-84 Development Committee titled "Department of Defense World Geodetic System 1984 - Its Definition and Relationships With Local Geodetic Systems". This report is available through the Defense Mapping Agency.

The TRANSIT System continues to be the reference system for ship navigation and surveyors both on land and in the broad ocean area, and for time dissemination.

6.0 FUTURE PLANS & SUMMARY

The U. S. Navy plans to continue to operate the system through 1996.

The plan is to operate the NOVA

and OSCAR Spacecraft to provide uniform global coverage during the remainder of the program with up to seven operational spacecraft consistent with satellite on orbit life and orbit dispersion. Figure 19 provides the calculated availability of the NNSS Constellation through 1996.

The TRANSIT System is healthy, and the plans are to continue to provide high accuracy outputs and good global earth coverage from the spacecraft as long as they last or until the end of 1996, depending on which comes first.

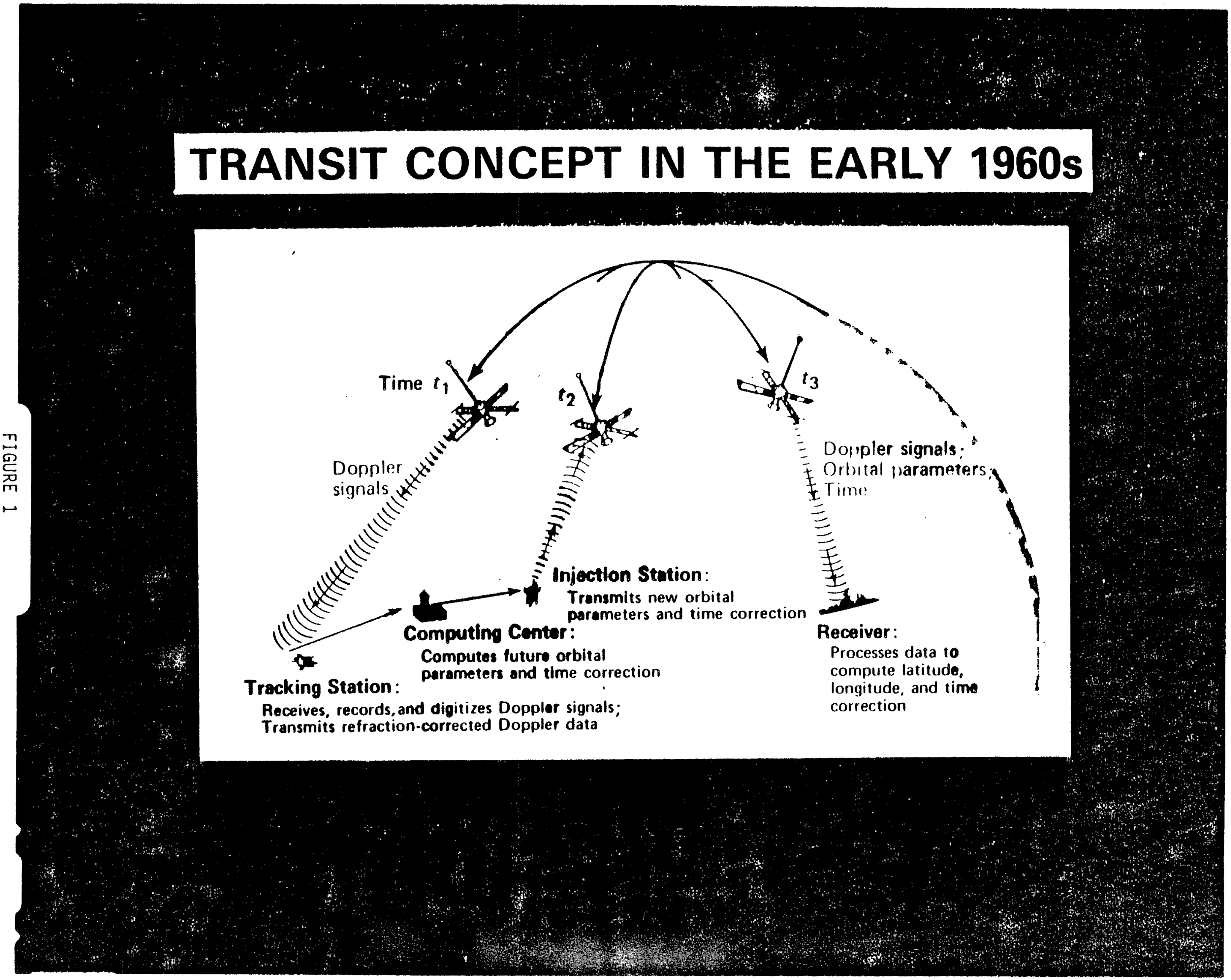

TRANSIT CONCEPT IN THE EARLY 1960s
Time t_1
t_2
t_3
Doppler signals
Doppler signals; Orbital parameters; Time
Injection Station: Transmits new orbital parameters and time correction
Computing Center: Computes future orbital parameters and time correction
Tracking Station: Receives, records, and digitizes Doppler signals; Transmits refraction-corrected Doppler data
Receiver: Processes data to compute latitude, longitude, and time correction

FIGURE 1

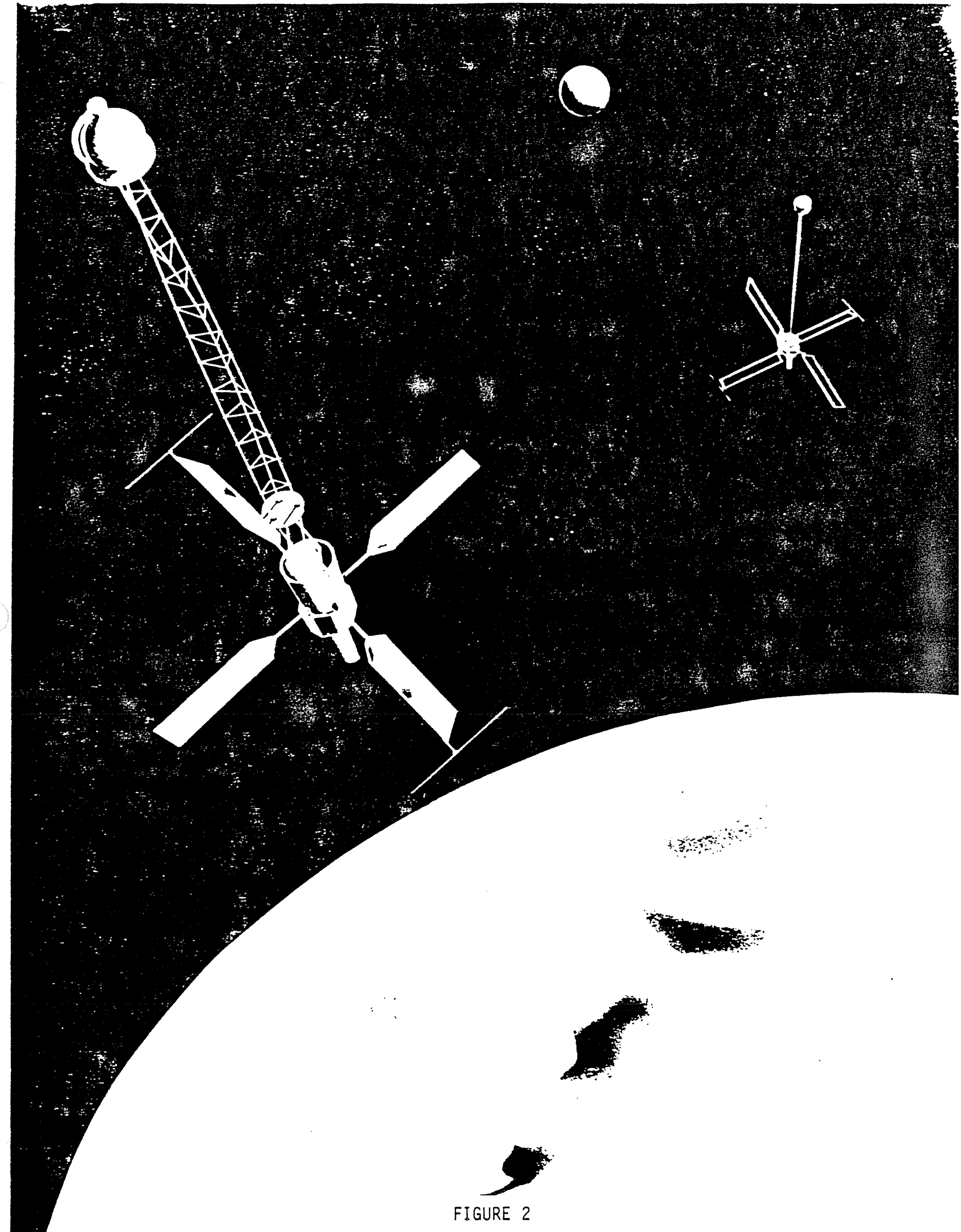


FIGURE 2

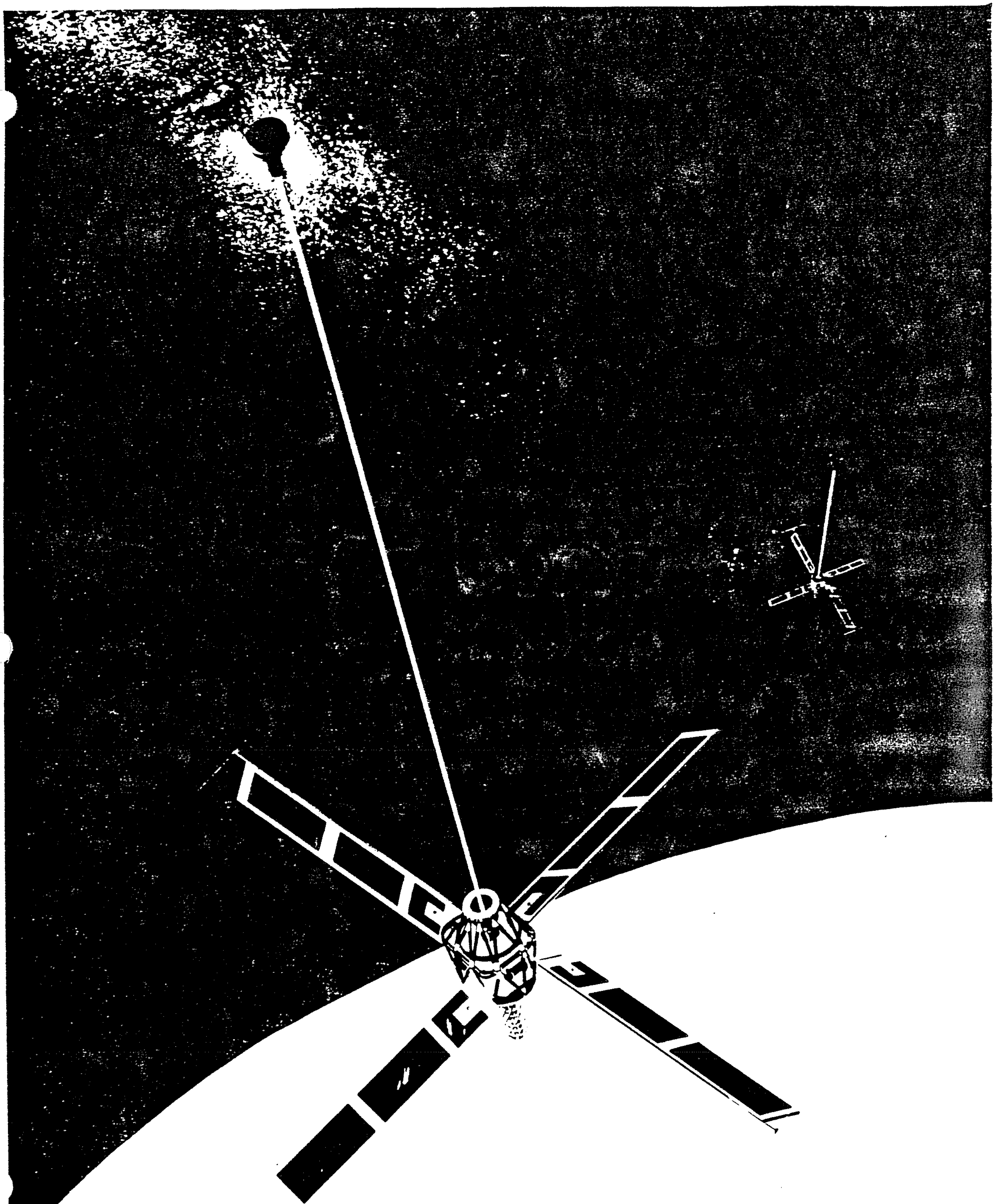


FIGURE 3

CHARACTERISTICS OF TRANSIT SATELLITES

CHARACTERISTIC	OSCAR	SOOS	NOVA
WEIGHT (POUNDS)	130	280	370
EPHEMERIS	16 HOURS	16 HOURS	8 DAYS
POWER OUTPUT/POLARIZATION			
400 MEGAHERTZ	2 WATTS/RHC	2 WATTS/LHC	5 WATTS/LHC
150 MEGAHERTZ	1 WATT/LHC	1 WATT/LHC	3 WATTS/LHC
GRAVITY GRADIENT STABILIZED	YES	YES	YES
STATION SEEKING/ORBIT ADJUST	NO	NO	YES
STATION KEEPING/ORBIT MAINTENANCE	NO	NO	YES
DRAG COMPENSATION	NO	NO	YES
ATTITUDE CONTROL	1 AXIS	1 AXIS	3 AXIS
OPERATIONAL FREQUENCY OFFSET (PARTS PER MILLION)	≈ -80	≈ -80	-84.48
MAINTENANCE FREQUENCY OFFSET	NO	YES	YES
PROGRAMMABLE COMPUTER	NO	NO	YES

RHC = RIGHT-HAND CIRCULAR POLARIZATION
LHC = LEFT-HAND CIRCULAR POLARIZATION

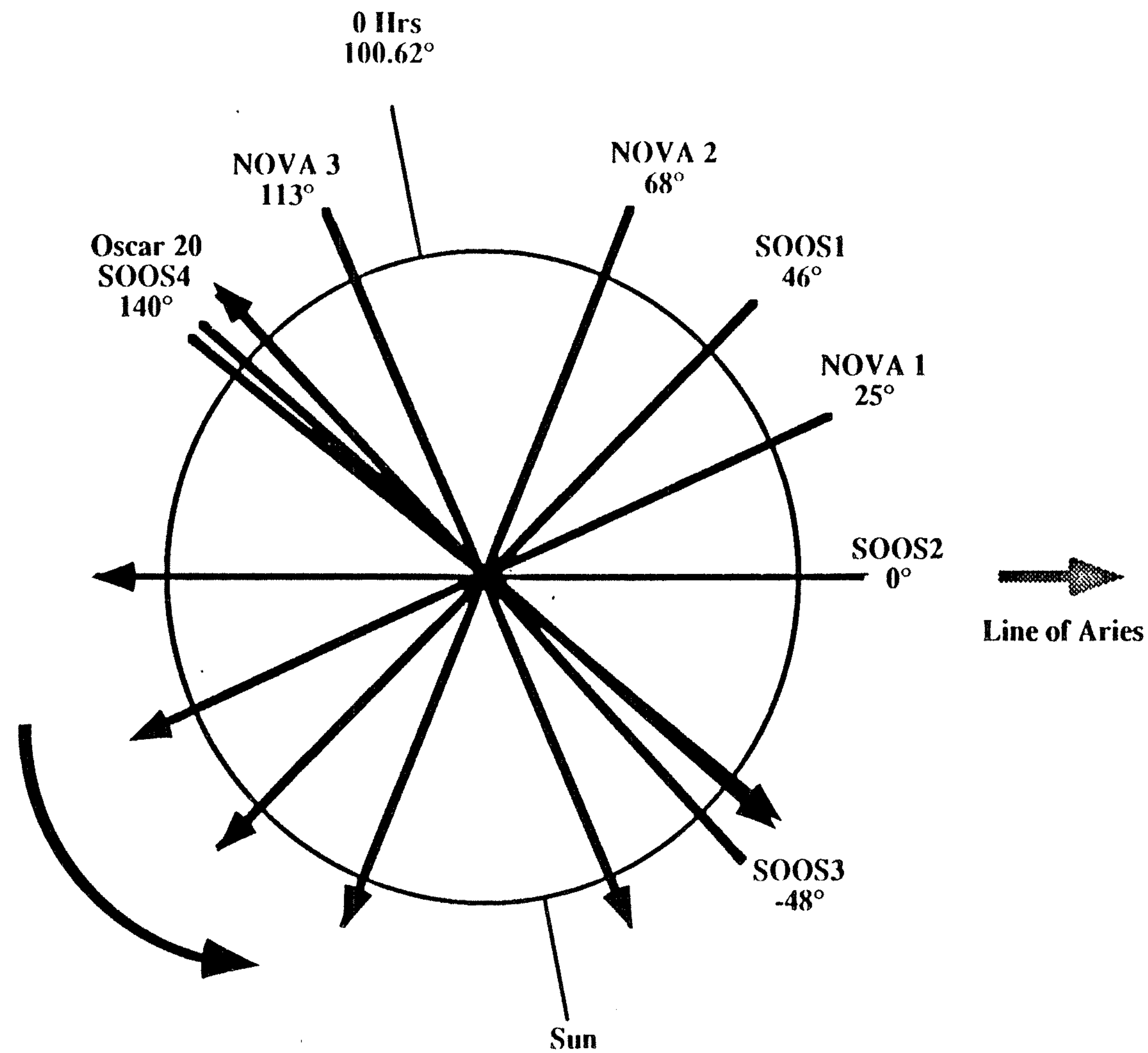
FIGURE 4

NNSS CONSTELLATION STATUS
(FEB 1989)

Payload	Satellite	Time in Orbit	Status
OSCAR 20	020	15Yr 3Mo	Operational
NOVA 1	048	7Yr 8Mo	Operational
NOVA 3	050	4Yr 3Mo	Operational
SOOS 1	024	3Yr 6Mo	Operational
	030	3Yr 6Mo	Stored in Orbit
SOOS 2	027	1Yr 4Mo	Operational
	029	1Yr 4Mo	Stored in Orbit
SOOS 3	023	0Yr 9Mo	Operational
	032	0Yr 9Mo	Stored in Orbit
NOVA 2	049	0Yr 7Mo	Operational
SOOS 4	025	0Yr 5Mo	Stored in Orbit
	031	0Yr 5Mo	Stored in Orbit

FIGURE 5

NNSS Orbit Planes
Viewed from North Pole, January 1989



Name of Satellite at Ascending Node, Arrow at Descending Node.

FIGURE 6

Orbit Precessions Over Time

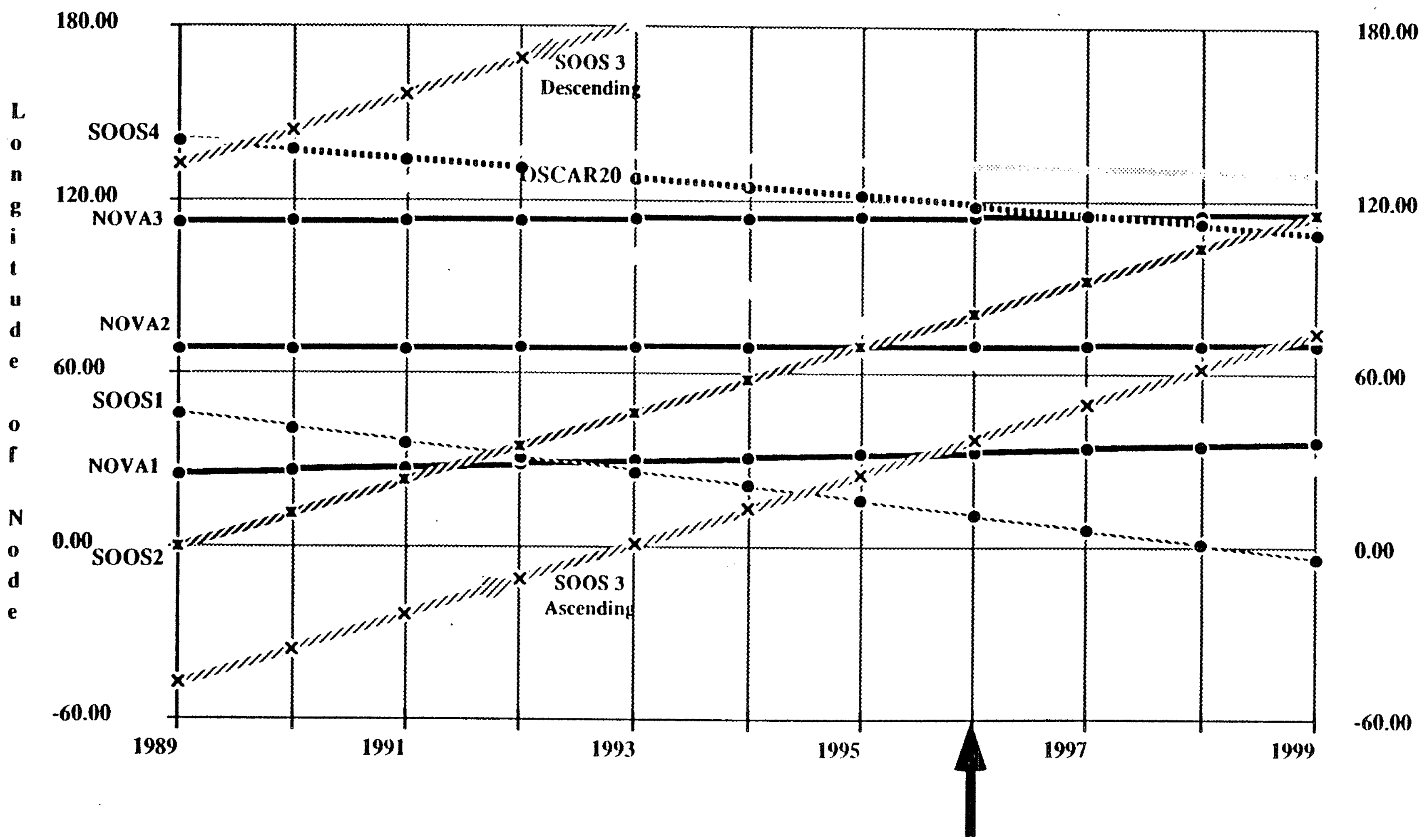
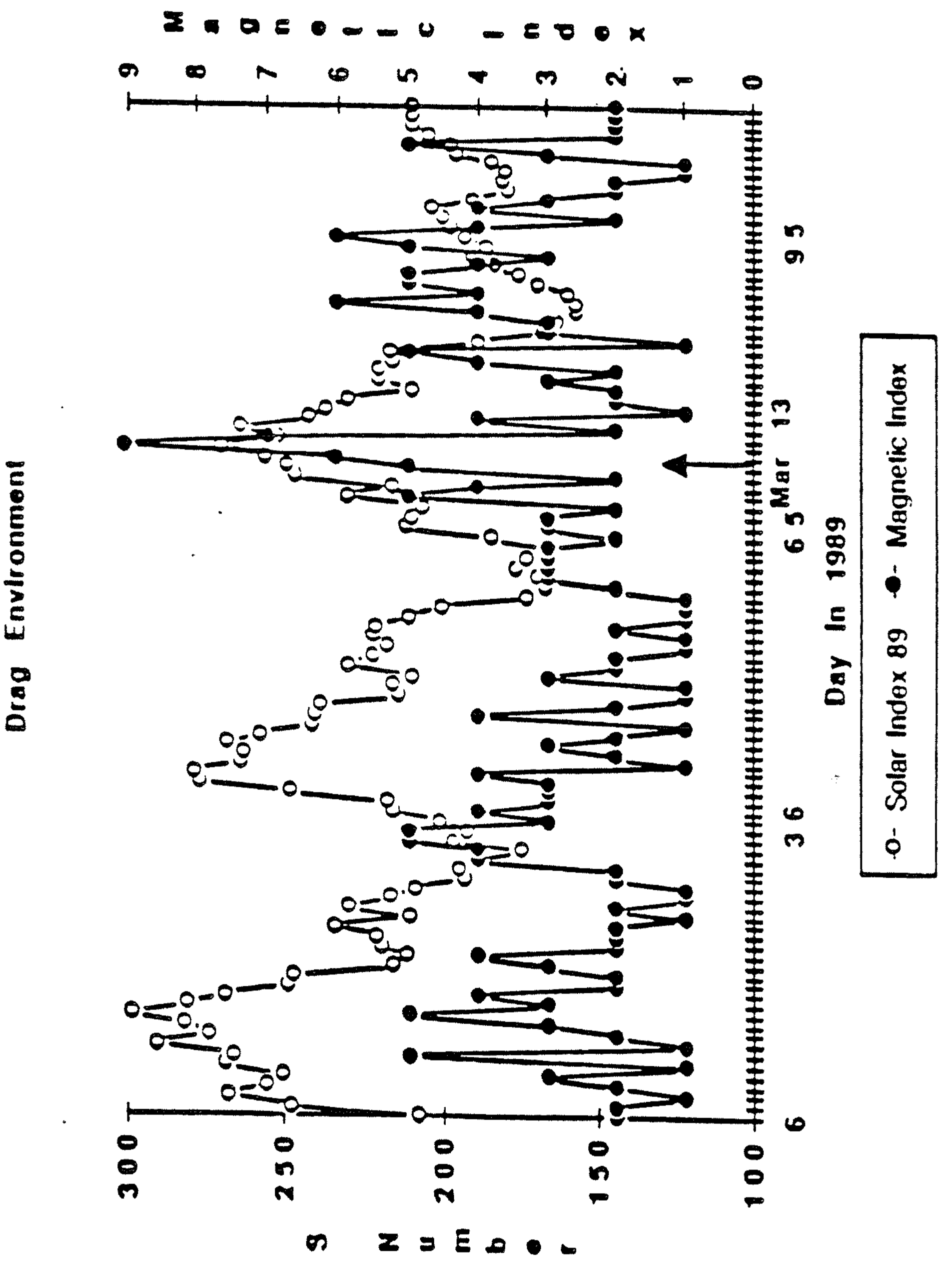
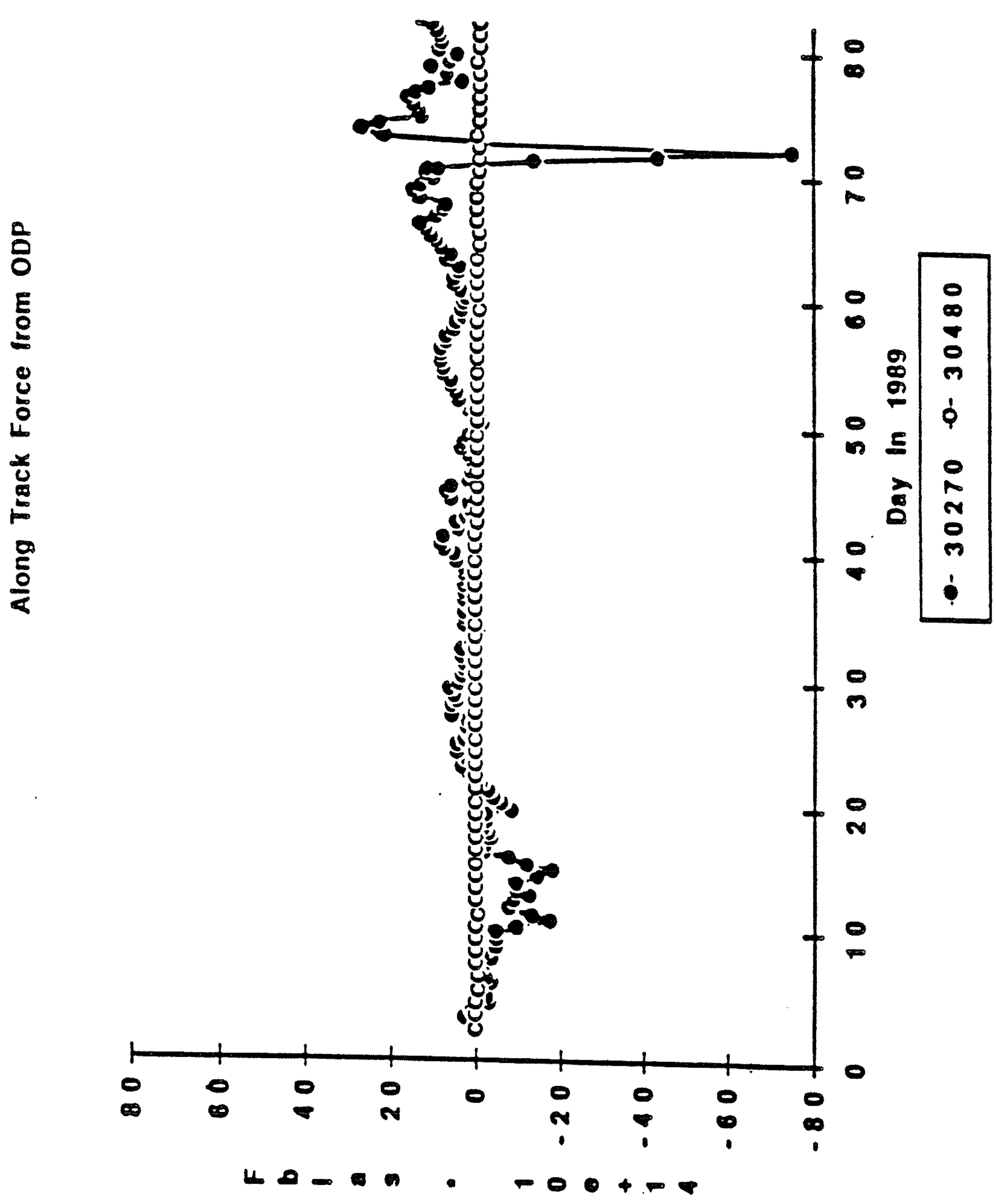


FIGURE 7



Drag Environment
Day In 1989
-o- Solar Index 89
-●- Magnetic Index
S Number
Magnetic Index
300
250
200
150
100
9
8
7
6
5
4
3
2
1
0
6
36
65
Mar 13
95

FIGURE 8



Along Track Force from ODP
80
60
40
20
0
-20
-40
-60
-80
0
10
20
30
40
50
60
70
80
Day In 1989
30270
30480

FIGURE 9

ILLUSTRATION OF DISCOS AS USED ON THE TRIAD SATELLITE

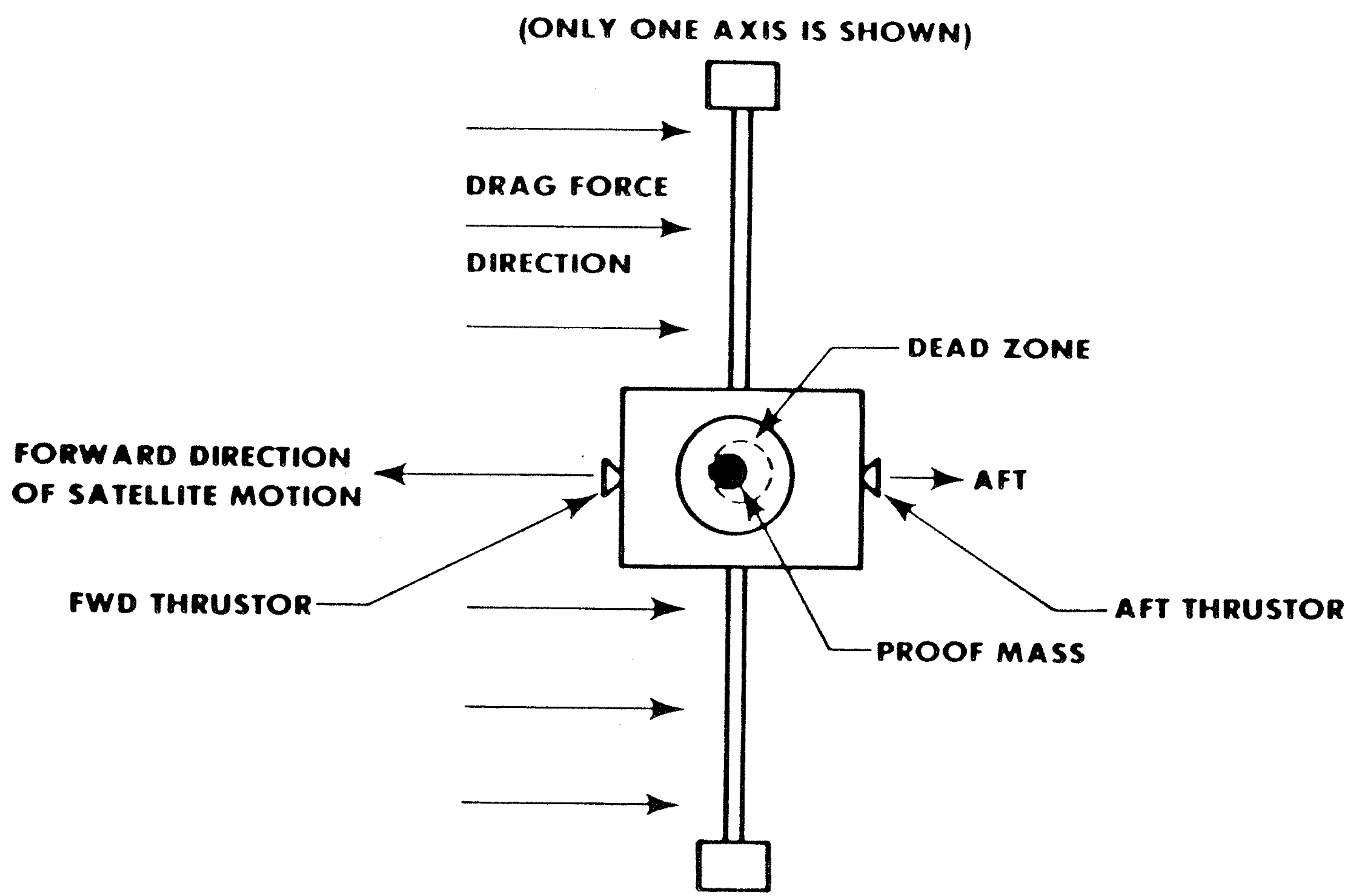
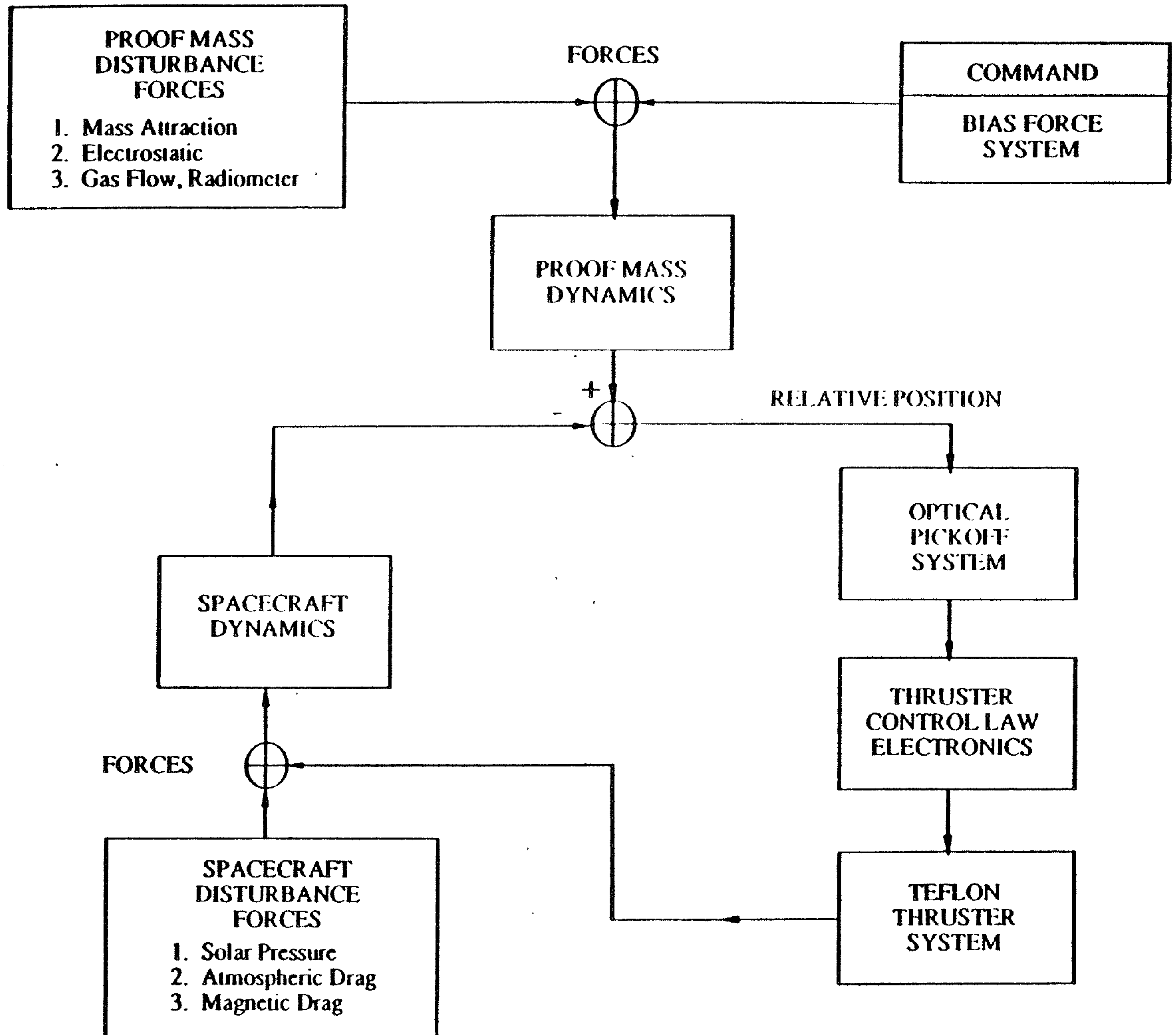


FIGURE 10



SINGLE-AXIS FUNCTIONAL DIAGRAM

FIGURE 11

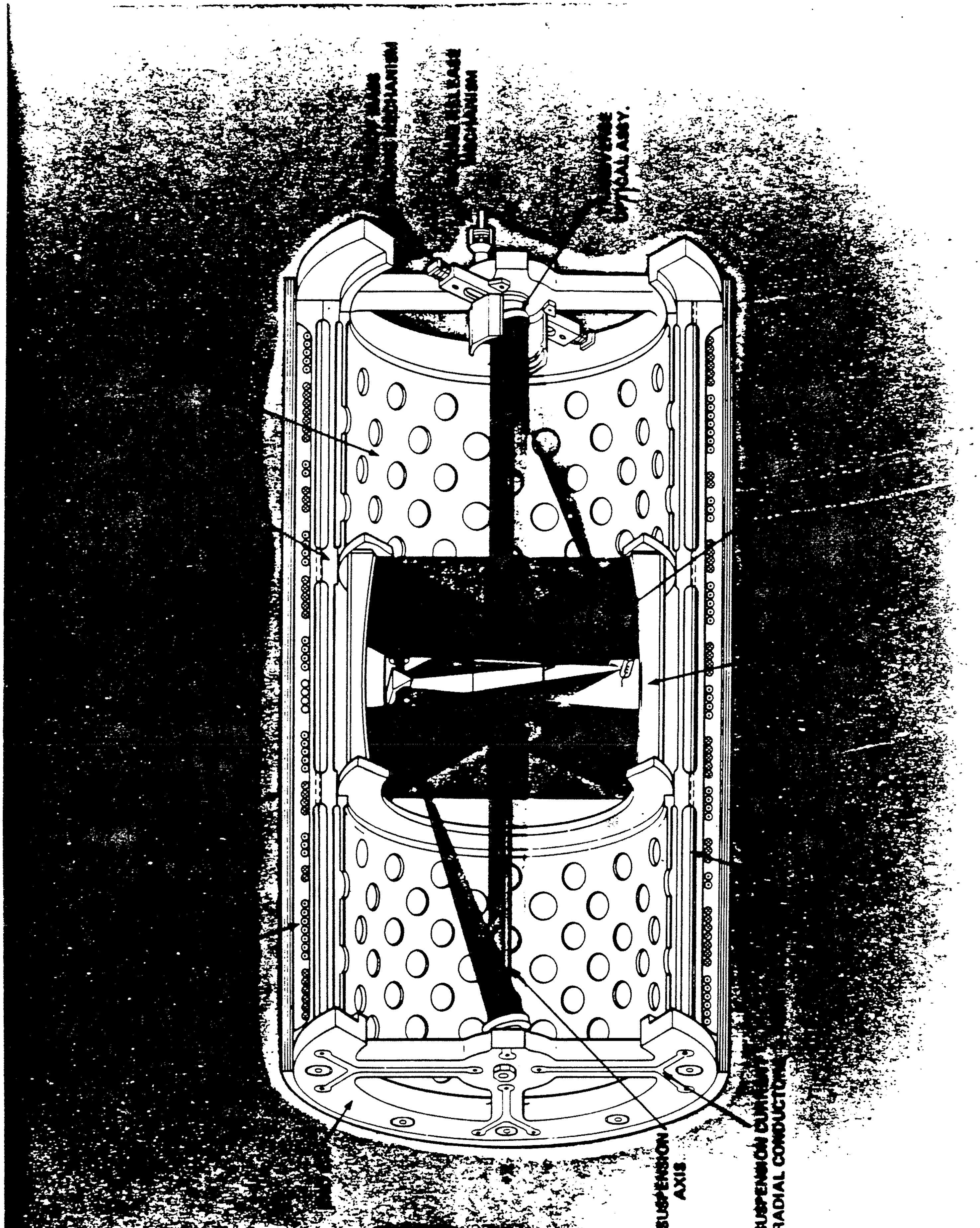


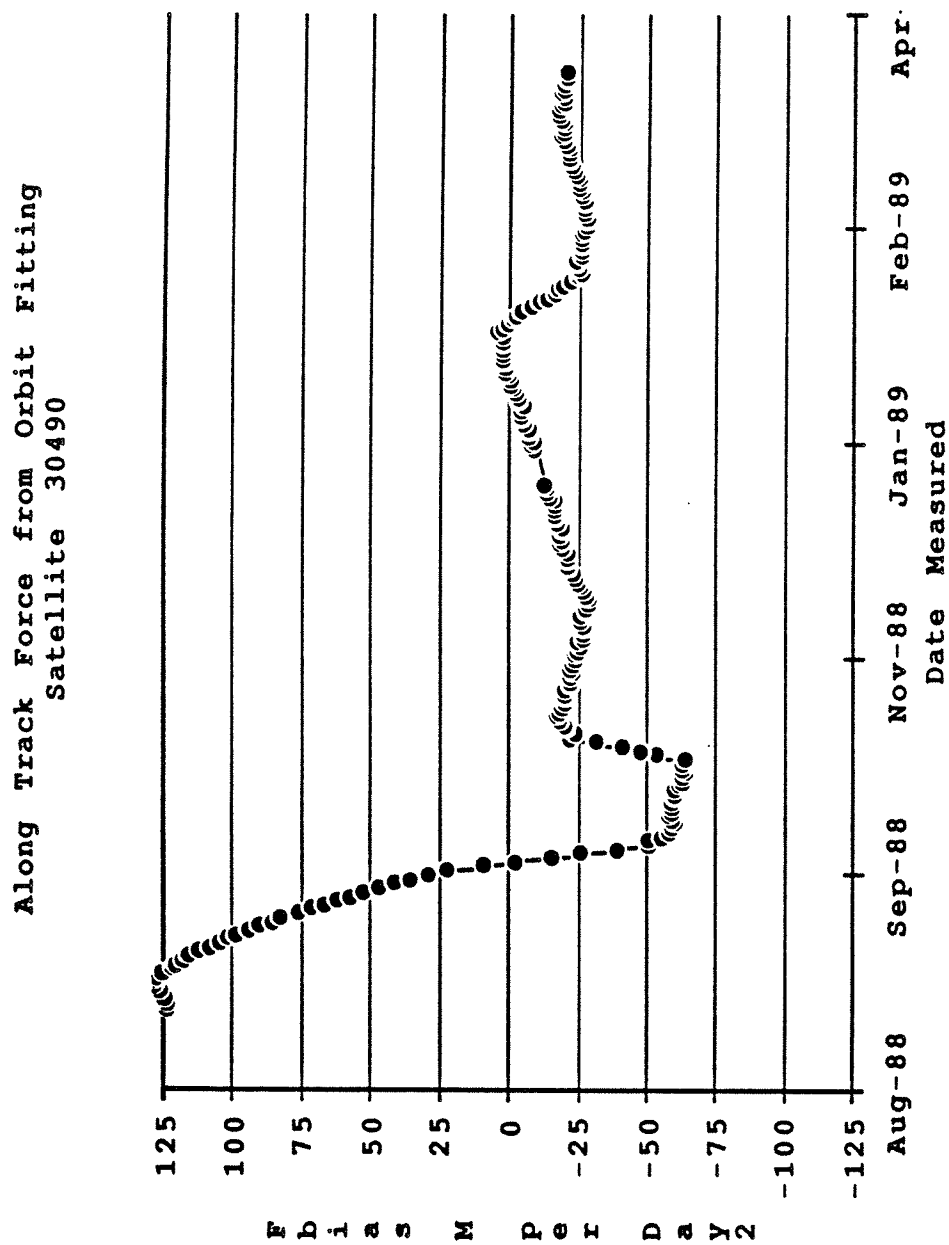
FIGURE 12

FIGURE 13

TEFLON SOLID PROPELLANT PROPULSION SYSTEM (TSPPS) CHARACTERISTICS

- THRUST – 80 MICROPOUNDS
- RATE – MAX/FIRING/SECOND
  NOMINAL 3.7×10^5/YEAR
  TOTAL CAPACITY 6.5×10^6
- SYSTEM WEIGHT – 15 POUNDS
- POWER – 30 WATT SECONDS/FIRING

FIGURE 14



Along Track Force from Orbit Fitting
Satellite 30490
Fbias M per Day2
125
100
75
50
25
0
-25
-50
-75
-100
-125
Aug-88
Sep-88
Nov-88
Jan-89
Feb-89
Apr
Date Measured

FIGURE 15

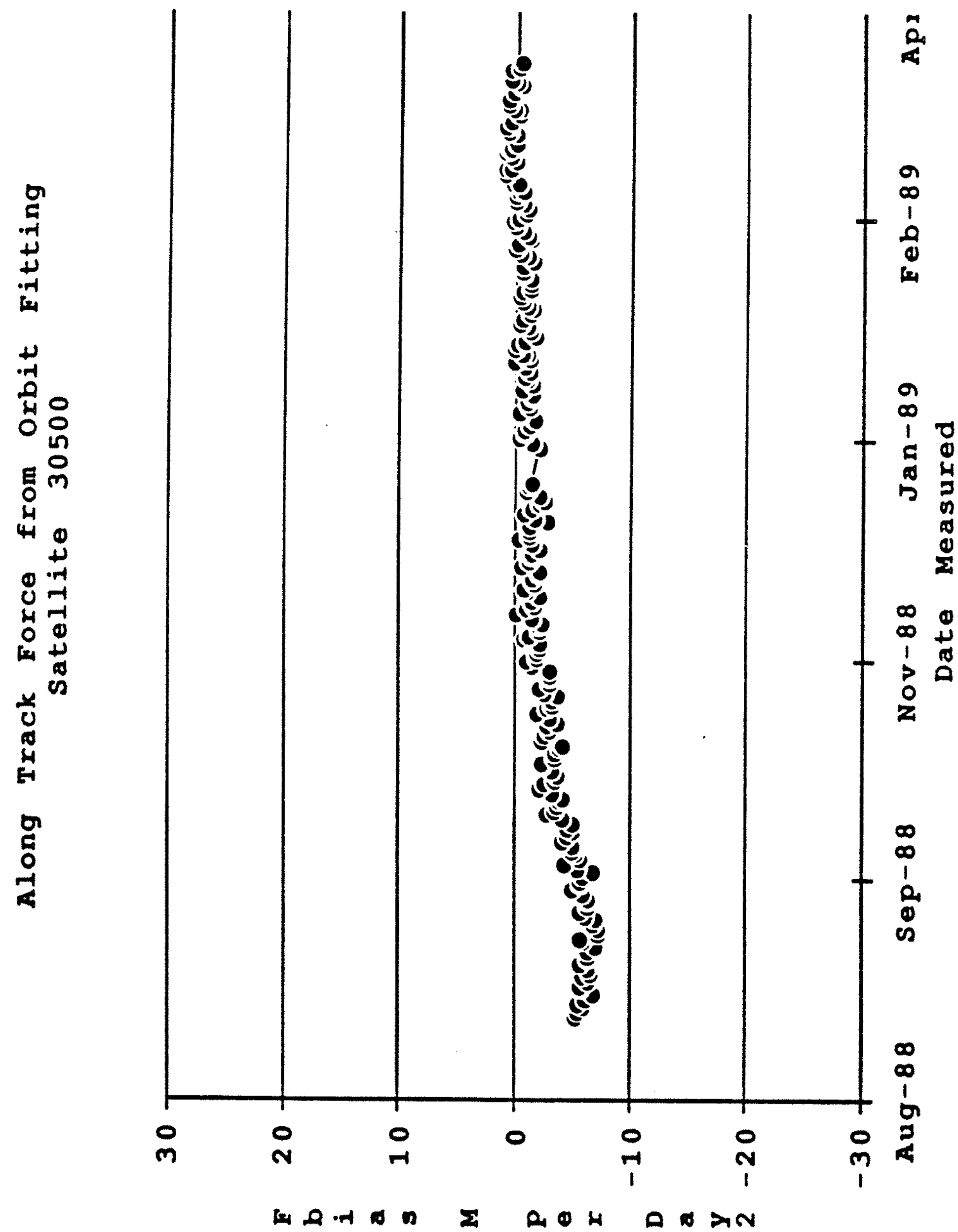

Along Track Force from Orbit Fitting
Satellite 30500
30
20
10
0
-10
-20
-30
Fbias M per Day2
Aug-88
Sep-88
Nov-88
Jan-89
Feb-89
Ap
Date Measured

FIGURE 16

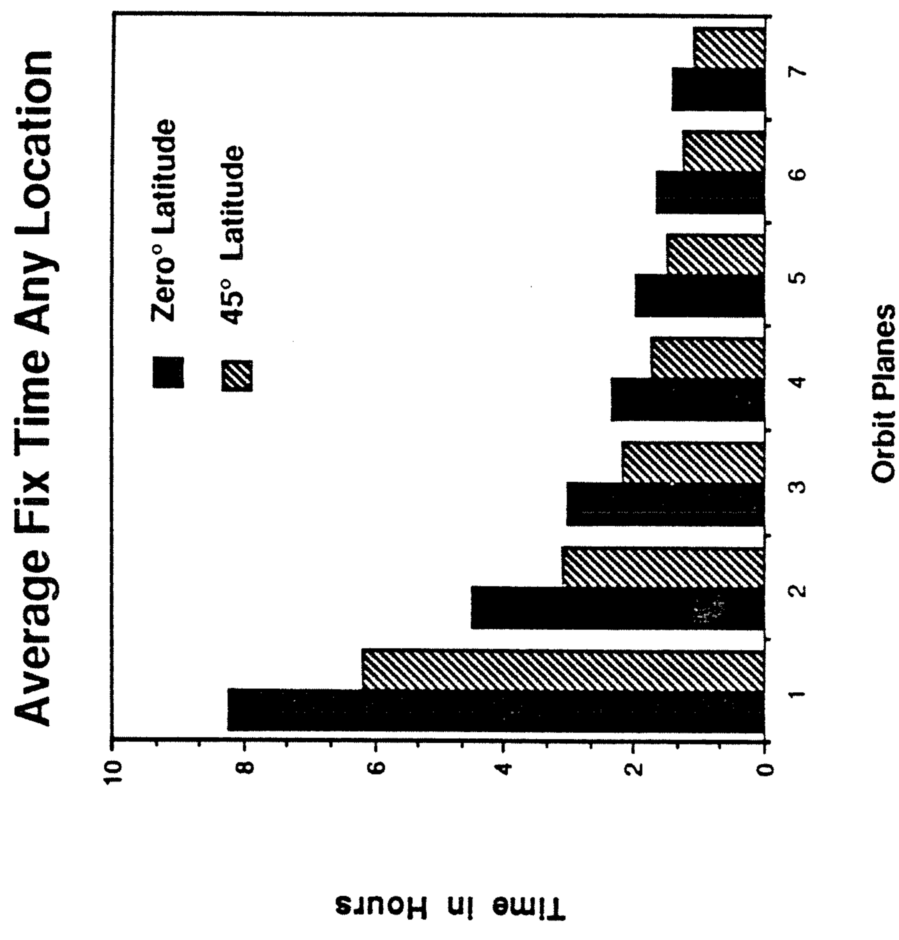

Average Fix Time Any Location
Zero° Latitude
45° Latitude
Time in Hours
0
2
4
6
8
10
1
2
3
4
5
6
7
Orbit Planes

FIGURE 17

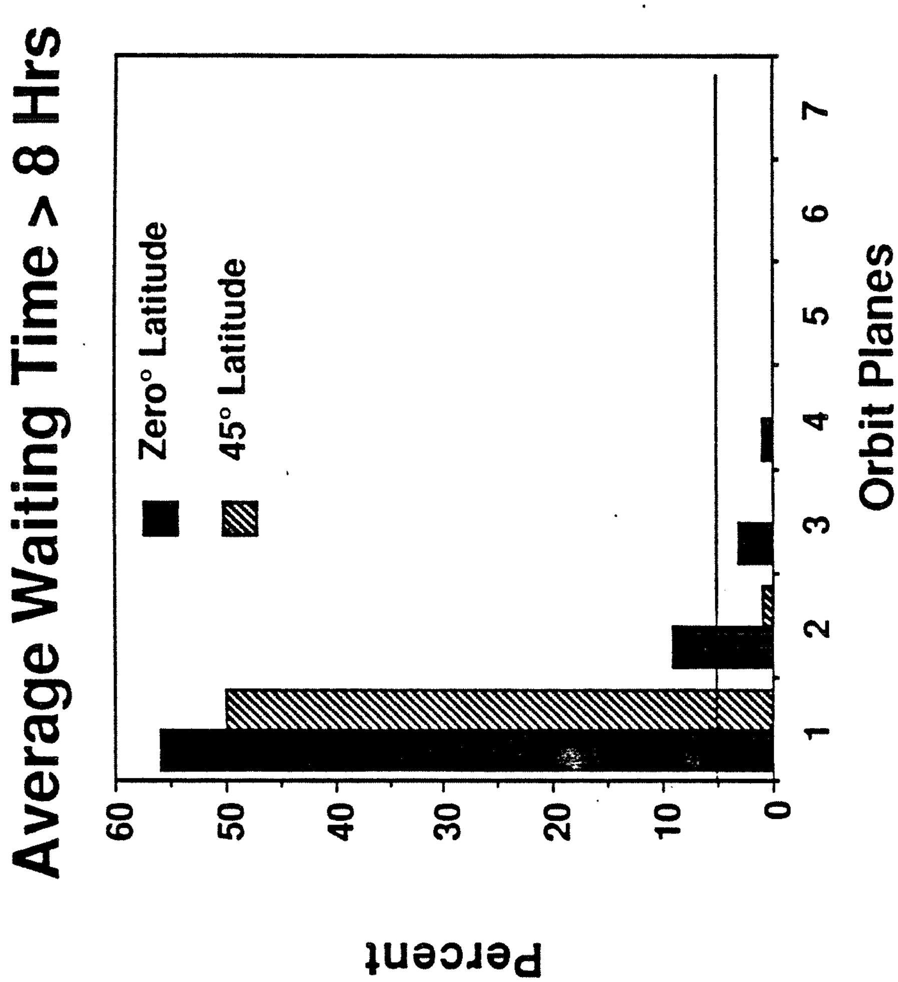

Average Waiting Time > 8 Hrs
Zero° Latitude
45° Latitude
Percent
60
50
40
30
20
10
0
1
2
3
4
5
6
7
Orbit Planes

FIGURE 18

CONSTELLATION AVAILABILITY (CALCULATED)

ASSUMPTIONS:

1. OSCAR OPERATING LIFE - 12 YRS.
2. NOVA OPERATING LIFE - 8 YRS.

PROBABILITY OF HAVING:	1990	1993	1996
AT LEAST ONE PLANE	1.000	1.000	1.000
AT LEAST TWO PLANES	1.000	1.000	1.000
AT LEAST THREE PLANES	1.000	1.000	0.998
AT LEAST FOUR PLANES	1.000	0.999	0.969

FIGURE 19

STARSYS, Inc.
File No. 33-DSS-P-90(24)
Pleading File

Comments filed August 13/14, 1990:

Battelle
Communications Satellite Corporation - WSD
ECOSYSTEMS International Inc.

English Automotive, LTD. (rec'd mailroom 8/16/90)
Houston Data Transmission Company, Inc. (rec'd mailroom 8/15/90)
LTM Corporation of America (rec'd mailroom 8/15/90)
Oceanweather Inc. (rec'd mailroom 8/16/90)
Vaudrey & Associates, Inc. (rec'd mailroom 8/15/90)

Comments filed August 17, 1990:

Geostar Corporation
KPMG Peak Marwick
National Oceanic and Atmospheric Administration
(U.S. Dept. of Commerce)
Orbital Communications Corporation