/

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

RECEIVED

JUN 15 2000

FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

In Re)
)
Application of Maritime)
Telecommunications Network, Inc.) File No. 0100-EX-RR-1999
for Renewal of Experimental)
Authorization (Call Sign KI2XEE))

To: Chief, Office of Engineering and Technology

REPLY TO OPPOSITION

The Fixed Wireless Communications Coalition ("FWCC"), the Association of American Railroads ("AAR"), the American Petroleum Institute ("API"), Association of Public-Safety Communications Officers International ("APCO") and the United Telecom Council (formerly the Utilities Telecommunications Council, or "UTC"), (hereinafter collectively referred to as "Joint Petitioners"), hereby reply to the "Opposition to Petition for Expedited Action" filed on May 24, 2000, in connection with the above-captioned application for renewal of the experimental license of Maritime Telecommunications Network, Inc. ("MTN").[1]

In their "Petition for Expedited Action" filed on May 10, 2000, the Joint Petitioners requested the Commission to act expeditiously and favorably on their long-pending petitions requesting denial of MTN's renewal application, thus bringing to a

---

[1] In response to Joint Petitioners' "Motion for Extension of Time," the time for filing a reply to MTN's Opposition was extended to June 15, 2000.

halt the ill-advised "experiment" initiated several years ago to demonstrate the feasibility of allowing the operation of satellite earth stations aboard vessels ("ESVs") in the 5925-6425 MHz band (the "6 GHz Band"), which is shared with the Fixed Service (FS). In their May 10 Petition, the Joint Petitioners demonstrated that the successful coexistence of ESVs with the Fixed Service is not feasible; that the experiment was a failure; and that MTN's experimental license should not be renewed. Specifically, the Joint Petitioners showed that the interference criteria being used for ESV "coordinations" were inadequate to protect digital FS receivers from ESV interference and that the FCC's coordination regime as applied to the mobile nature of the ESV operations is essentially unenforceable and therefore unworkable.

I. SUMMARY OF MTN OPPOSITION

In its Opposition,[2] MTN denigrates as "purely theoretical" the showing by Joint Petitioners that the interference coordination criteria used by MTN are inadequate to protect Fixed Service receivers. In this regard, MTN suggests that the only way to demonstrate that its ESV operations are capable of causing harmful interference is to allow such interference to take place. In MTN's words, the threat of interference is not "real" unless and until it has been "substantiated by real world results."[3]

---

[2] In addition to filing its Opposition, MTN also filed a "Motion to Strike" the Petition. Joint Petitioners do not intend to dignify that Motion with a response except to say that their Petition was entirely consistent with the Commission's rules (see, e.g., Section 1.1 of the rules).

[3] MTN Opposition at 4.

MTN also argues that Joint Petitioners' position that ESV interference cannot be "seen" on an operating FS system means that the interference is incapable of causing harm. As explained below, this argument evidences a fundamental lack of understanding of how digital microwave systems work.

II. MTN'S INTERFERENCE CRITERIA ARE INAPPROPRIATE AND INADEQUATE

Attached to this Reply is a "Supplemental Engineering Statement" by Mr. M. Philip Salas responding to the arguments in MTN's Opposition and addressing MTN's claim that its short-term interference protection objective of –131 dBW/4kHz is the proper criterion for ESV coordination. After examining the "best case" ESV scenario, Mr. Salas concludes that even in the "best case" the ESV interference resulting from typical movement of a ship will cause interference into the main beam of an FS receiver for a period of 14-20 seconds in duration (depending upon the size of the receiving antenna).[4] If this occurred only once per year, the duration of the interference would exceed, for all practical purposes, the short-term per-hop allowance of 16 seconds per hop per year.[5] It would also exceed greatly the "real world" 2-second outage limit for the Carrier Group Alarm (CGA) discussed in Mr. Salas' April 10 Engineering Statement

---

[4] See attached Supplemental Engineering Statement at 8-9.

[5] Id. at 9, 13.

which accompanied the Joint Petitioners' "Petition for Expedited Action" filed on May 10, 2000.[6]

Mr. Salas also makes clear in his attached Supplemental Engineering Statement that the appropriate interference objective to be used for ESV/FS coordinations is a long-term interference criterion of –170 dBW/4kHz. This value is consistent with Appendix S7 (formally Appendix 28) of the ITU Radio Regulations, Section 2.3.1, note 2, which is incorporated by reference in Section 25.251(b) of the FCC's rules governing coordination between satellite earth stations and terrestrial FS networks.[7]

Finally, Mr. Salas addresses MTN's dismissal of his proposed coordination criterion as nothing but "theory" by comparing theoretical and "real world" results with respect to a particular digital radio. Attached to Mr. Salas' Supplemental Engineering Statement are carrier-to-interference curves for a 128 QAM digital radio, together with relevant data for Alcatel's 3-DS3 digital radio, all of which demonstrate that theory and "real world" practice are in agreement with respect to the effect of MTN's proposed interference criteria.[8]

---

[6] Id. at 8.

[7] Id. at 12.

[8] The short-term interference noise-floor using MTN's –131 dBW/4kHz objective is 33 dB above the theoretical noise floor, which means that the radio threshold would be degraded 33dB short-term, which is approximately equal to the entire fade margin designed into a typical 6 GHz FS radio link.

The conclusion is inescapable that MTN has been using interference criteria for its coordinations that are improper, in conflict with FCC rules and ITU Radio Regulations, and inadequate to protect digital FS systems.

III. MTN CONFUSES THE INABILITY TO IDENTIFY THE SOURCE OF INTERFERENCE WITH THE ABSENCE OF INTERFERENCE.

Joint Petitioners noted that they cannot identify ESVs as a source of interference into an FS receiver without turning off the desired incoming signal and monitoring for the interference. MTN's response says, in essence, that if a potential interference source cannot be identified while an FS link is operating, then there can be no interference. MTN is confusing two separate concepts: (1) the existence of interference that can cause an outage in a digital microwave system, and (2) the ability of the system operator to identify the facility causing the interference. MTN's failure to recognize that distinction reveals its lack of understanding of how digital microwave systems operate.

As explained by Mr. Salas in his April 10 Engineering Statement and in his Supplemental Engineering Statement attached hereto, interference at a level approximately 25 dB below the desired signal (regardless of whether the signal is in a fade or not) will cause an outage. However, up until the time of the outage, only the desired signal would be visible on a spectrum analyzer. The only way to identify the source of the interfering signal would be to turn off the desired signal and monitor for interference. Even that task is made extremely difficult, however, by the changing nature of the interference due to its origination from a moving ship.

By asking in its Opposition, "If the interference is not detectable while the system is operating, where is the harm?", MTN reveals a disturbing ignorance of how digital FS systems operate. Obviously, the "harm" is that the combined effect of path fading and interference will cause the system to shut down. The interference is not "detectable" on a spectrum analyzer prior to the outage because the interfering signal is masked by the desired signal, but it is certainly "detectable" (in the form of an outage) by the FS system it interferes with. The outage is the harm we seek to avoid.

Equally disturbing is MTN's suggestion that "a good way to test whether these [ESV] operations would cause harmful interference" is to "increase the number of ships" equipped with ESVs.[9] According to MTN, if harmful interference were to occur, then the Commission could "terminate the experiment." But, the FS systems operated by Joint Petitioners are too important to be used as guinea pigs for MTN's experimental whims. They are used to control vital infrastructure functions such as police, fire and emergency support communications; delivery of electric, gas and water utility services; remote control of railroad and oil and natural gas pipeline operations; and to provide cellular telephone backhaul services. And even when outages caused by interference from MTN's operations do occur, FS operators will still be unable to pinpoint particular ESVs as the source, for the reasons explained above. MTN's suggestion that it be allowed to continue exposing these systems to interference until outages and

---

[9] MTN Opposition at 8.

disruptions can somehow be traced back to MTN's doorstep is irresponsible and absurd.

IV. CONCLUSION

Sound spectrum management requires that frequency sharing scenarios be premised on predictive values that are based on accepted engineering techniques, including appropriate mathematical modeling. Indeed, the entire history of spectrum management at the ITU and the FCC is grounded on principles of predictability based on the applicable laws of physics. As demonstrated by Mr. Salas in his two Engineering Statements in support of Joint Petitioners, it is absolutely certain and predictable that ESVs, if allowed to continue operating at the power levels for which they have been heretofore "coordinated," will cause harmful interference to digital FS systems operating in and near coastal and port locations. MTN has not refuted this, and indeed it cannot. MTN's response is that it should be allowed to continue to operate (and to expand its operations), until such time as an FS operator manages to prove that a transient ESV interference event caused a shut-down of vital FS communications networks. It is irresponsible for MTN to ask the Commission to overlook sound engineering analysis in favor of a test that requires the failure of essential vital infrastructure. The Commission must not allow that to occur.

For the foregoing reasons, and for the reasons set forth by Joint Petitioners elsewhere in the record of this proceeding, the Commission should act expeditiously to terminate the MTN experiment concerning ESV deployment at 6 GHz by denying MTN's application for renewal of its experimental license.

Respectfully submitted,

AMERICAN PETROLEUM INSTITUTE

Wayne Black JS

Wayne V. Black
Peter A. Saari
Keller and Heckman LLP
1001 G Street, N.W.
Suite 500 West
Washington, D.C. 20001
(202) 434-4100

ASSOCIATION OF AMERICAN RAILROADS

Julian Shepard

Julian L. Shepard
Verner, Liipfert, Bernhard,
McPherson and Hand, Chartered
901 - 15th Street, N.W.
Suite 700
Washington, D.C. 20005-2301
(202) 371-6111

UNITED TELECOM COUNCIL

Jeffrey Sheldon JS

Jeffrey L. Sheldon
Thomas Goode
UTC
1140 Connecticut Avenue, N.W.
Suite 1140
Washington, D.C. 20036
(202) 872-0030

FIXED WIRELESS COMMUNICATIONS COALITION

Leonard Raish JS

Leonard R. Raish
Mitchell Lazarus
Fletcher, Heald & Hildreth, P.L.C.
1300 North 17th Street
11th Floor
Arlington, VA 22209
(703) 812-0440

ASSOCIATION OF PUBLIC SAFETY COMMUNICATIONS OFFICIALS INTERNATIONAL, INC.

Robert Gurss JS

Robert M. Gurss
Shook, Hardy & Bacon, L.L.P.
600 14th Street, N.W.
Suite 800
Washington, D.C. 20005
(202) 662-4856

Dated: June 15, 2000

Attachment: Supplemental Engineering Statement

SUPPLEMENTAL ENGINEERING STATEMENT OF M. PHILIP SALAS

The purpose of this Supplemental Engineering Statement is to respond to the issues raised by MTN and Daniel Collins of Pinnacle Telecom Group, in MTN's "Opposition" filed on May 24, 2000.

Supplemental Background of Author

From 1972 through 1979, Mr. Salas worked as a Circuit Design Engineer developing analog, RF, and digital modules and software for phased-array radar systems and analog microwave point-to-point radios. In 1979, he assumed Project Engineering responsibilities for analog radio development, and in 1984 was selected as a "Rockwell Engineer of the Year" for his leadership in long-haul microwave radio development. At that time he was selected to head a digital radio product development group at Rockwell, following which he assumed complete responsibility for all digital radio product developments in 1986. Since 1991, Mr. Salas has been the Chairman of TIA TR14.11 and, as such, was responsible for TSB Bulletin 10-F (Interference Criteria for Fixed Microwave). He has been a member of NSMA for approximately 10 years, served on the Board of Directors of NSMA from 1996-1998, served as NSMA President from 1998-2000, and was recently re-elected as NSMA President for another two-year term. He is also currently the Chairman of the Technical Committee of the Fixed Wireless Communications Coalition. As part of his digital radio development responsibility, Mr. Salas has been involved in addressing and resolving "real-world" interference problems for Rockwell/Alcatel microwave radio customers. In that role, he has had occasion to send R&D engineers into the field many times per year to help identify sources of interference, and has concluded that it often takes from several weeks to several months to track down interference problems caused by fixed interfering sources.

General Response to MTN's Opposition

MTN's Opposition reveals that it does not understand the concept of "finding interference" and demonstrates a fundamental lack of technical understanding of microwave route design and the engineering methodologies used to calculate system outages caused by interference. MTN apparently is not aware that, over the long term, microwave routes develop fades of widely varying depths caused by a number of propagation anomalies. The occurrence of these phenomenon are predictable, according to algorithms founded in basic research, which have been proven over time and have been accepted by the microwave engineering community for many years. Nearly all microwave routes are designed to a required level of availability based on these algorithms. Permitted design outage times, usually on the order of seconds per month, are used to determine the depth of fading that will be tolerated before the receiver signal level drops below a usable level. The path will experience an outage only during the deepest fades. Should interference be present during a fade when the receiver is getting a relatively weak but still acceptable signal, an outage will occur. The ratio of outage time to fade depth is such that a 10 dB degradation of the fade margin caused by increased interference will produce about 100 times the design outage time.

From the above description, it should be clear that even a low level of ESV interference which occurs during a fade can create an outage in a microwave system. Higher levels of interference, such as the –131 dBw/4 kHz level "coordinated" by MTN, can cause an outage when the Fixed Service microwave receiver is unfaded! And, while these levels of interference are causing an outage, they are impossible to view. To reiterate: An interfering signal approximately 25 dB below the desired signal will cause a digital microwave receiver to experience an outage. The desired receive signal will be all that can be visibly seen on a spectrum analyzer because it is over 300 times stronger than the interfering signal, and thus the interfering signal would be completely "buried" by the desired signal. The interference will cause the user to experience an outage, but unless the user turns off his incoming signal, he will be unable to view the interfering signal and thereby prove that this is what caused the outage. In order to confirm that the cause of the outage was unacceptable ESV interference, the user must have transmitter sites manned with personnel ready to turn off their transmitters at a moment's notice (thereby continuing to disrupt system traffic for an extended period of time) because the interference will only be present seconds-to-minutes at a time. A spectrum analyzer must then be attached to the radio in a manner that will permit a technician to observe the bandwidth of interest. Even if the system transmitter power were decreased to purposely "fade" the received signal to the minimum acceptable level for the tests, incoming ESV test interference would adversely affect service and, at the same time, be impossible to measure in the presence of the desired signal.

MTN argues that "those designing the new digital equipment should have designed it to withstand potentially interfering signals that may be received from transmitters operating within the established criteria..." But as most engineers know, there are certain physical laws that cannot be violated. As spectral efficiency is increased, modulation complexity also is increased, thereby increasing sensitivity to noise and interference. This can be improved somewhat with error-correct coding, but as the coding gain increases, information bits must be added, which increases the data rate and bandwidth, thereby decreasing information payload spectral efficiency. Trying to compensate for this through tighter filtering increases the signal's peak-to-average power, which decreases the available transmit power (reduces system gain). Also, as coding is added, there is an increase in absolute time delay that can violate telecommunications network requirements. It may interest MTN to know that the FCC requires modulation complexities of up to 64/128 QAM (3DS3/OC3 capacities) in order to meet the Part 101.141 equipment spectral efficiency requirements.

Again, sensitivities of modulation complexities to noise and interference are governed by laws of physics, and not necessarily "established criteria." As a point of interest, at the recent NSMA conference (May-22/23, 2000) Les Polisky of Comsearch stated that digital satellite receivers are 12 dB more sensitive to interference than analog satellite receivers. And this is undoubtedly due to the use of QPSK modulation, a form of digital modulation that is not legal for Part 101 users in frequency bands below 12 GHz due to its inadequate spectral efficiency (the more complex modulation schemes required of the Fixed Service are more sensitive). This shows that digital satellite designers are also unable to violate the laws of physics! MTN also states that the Fixed Service should "...attempt to develop industry standards for stricter criteria..." The short response is that MTN should consult TIA TSB-10F, which well-documents the interference criteria necessary for digital FS receivers. TSB-10 is recommended for use in FCC Part 101.105(3)(c), and by the NSMA in Recommendation WG5.95.044.

Response to MTN's Rejection of Mathematical Analysis

Both Mr. Collins and MTN criticize reliance by the Fixed Service on "theoretical mathematical analysis," and imply that it has no basis in the real world. They are incorrect. First of all, there can be no question about the kTB noise floor. The C/I is a function of modulation complexity and is a number well-supported by both theory and practice. Attached are C/I (Carrier-to-Interference) curves for a 128 QAM digital radio (OC3/30 MHZ bandwidth). Both CW-interfering and broadband-interfering (like modulation) curves are provided, showing that within the bandwidth of the FS receiver the impact of interference is virtually independent of the type of interfering signal. As can be seen from the curves, an interfering signal approximately 25 dB below the desired signal results in a 10^{-6} BER (the outage point for digital data). This is a result of the theoretical 30 dB critical C/N (128 QAM) minus a 5 dB coding advantage (Trellis + Reed-Solomon). All manufacturers make these measurements on their products as a requirement for frequency coordination of adjacent channels.

The following is a comparison of the "theoretical" and "real world" results:

kTB noise floor = -204 dBw/hz = -174 dBm/Hz

Theoretical noise floor (TNF) = -174 dBm/hz + 10 log (Bandwidth) + Noise Figure

For a 30 MHZ bandwidth radio with a 4 dB noise figure,

TNF = -174 + 10 log (30 x 10^6) + 4 = -95 dBm

Radio threshold = TNF + Critical C/N = -95 + 25 = -70 dBm

Attached is a data sheet for Alcatel's 3-DS3 6 GHz digital radio. Notice that the published radio threshold (10^{-6} BER) is -71 dBm typical/-68.5 dBm guaranteed (vs the

-70 dBm calculated above). This variation is due to production differences in receiver noise figure. So it appears that theory and practice agree.

The -154 dBw/4 kHz long-term interference noise floor is 10 dB above the theoretical noise floor, therefore the radio threshold is degraded by 10 dB long-term. The -131 dBw/4 kHz short-term interference noise-floor is 33 dB above the theoretical noise floor. Therefore the radio threshold is degraded 33 dB short-term. This is approximately equal to the entire fade margin designed into a typical 6 GHz FS radio link.

Background on Interference Protection Objectives

Mr. Collins argues that "several thousand transmitting earth stations in the 6 GHz band have been successfully coordinated in an environment that now includes about 10,000 microwave stations". On the surface this appears to be a sound basis for Mr. Collins to ignore "theoretical mathematical analysis." However, there are several reasons why these coordinations don't always result in harmful interference.

1.) If ALL of these "several thousand transmitting earth stations" were at exactly the -154/-131 dBw/4 kHz level into FS receivers, there would be severe interference experienced by the FS. In actuality, many of these earth stations are significantly better than -154/-131 dBw/4 kHz.

2.) Coordinations are normally done assuming the FCC "minimum standard" earth station antenna. Many of these antennas have much better side-lobe suppression than required (up to 10 dB better).

3.) Earth stations that are coordinated that just meet the -154/-131 dBw/4 kHz virtually always coordinate full-band even though they normally only occupy a small percentage of the band. Therefore, there is a good probability that they do not operate co-channel with nearby FS receivers.

4.) Finally, terrain clutter on land can add significant loss to the path. A recent case investigated at Richardson, Texas, showed 20 dB additional path loss due to terrain clutter. Terrain clutter is, of course, not a factor over water where ESVs operate.

Critical Contour Point Methodology

Mr. Collins states that he "performed a mathematical analysis that convinced [him] the duration of a worst-case interference exposure from any given ESV to any given microwave station would be of the duration considered by the FCC and ITU to be short-term". The "Critical Contour Point" methodology assumes that there is one point of maximum interference along a route, and if this clears, then everything else clears. Since there is only a single point to consider, the assumption in that the ESV will only be at that one point for an almost instantaneous period of time. Therefore, according to this flawed reasoning, interference will be short-term. Obviously, an important variable left out of the critical contour point methodology is the amount of time the interfering ESV signal is present at locations where it could produce interference to fixed receivers. Various modeling assumptions have been proposed that specify the vessel as always in motion and specify minimum vessel speeds, number of vessel traverses, vessel routes, etc. However, the variability of these assumptions in actual practice is very high. Vessels may change their route, decrease speed, travel in circles or stop unexpectedly (for example, to await availability of a berth or transit a foggy harbor). It is unrealistic to expect that decisions by the vessel's captain regarding these variables will be influenced by microwave interference design assumptions.

Besides not taking into account the above-mentioned real-world variations, the "Critical Contour Point" methodology ignores the real-world duration of the individual interference events. Not only does the real-world duration take the interference events well out of the "short-term interference" condition, it also violates the 0.0025% short-term yearly requirement. Another complicating factor is that the duration of individual events must remain at less than 2-3 seconds or they will cause a major system disruption, as discussed in the author's previous “Engineering Statement” dated April 10, 2000. Some very simple calculations will illustrate the problem.

First, assume a "best case" for the ESV, where the ship is just one mile off shore, travelling parallel to the shore and at right angles to an affected microwave path. Also assume that the microwave receiver is on the shore pointing out to sea. This is normally not a realistic case except when the FS hop crosses a body of water. However, if the FS receiver is moved further back from the shore, the interference duration will be longer. Again, the purpose is to show a "best ESV" case.

Assume the ESV is travelling at 5 knots (minimum speed agreed to by the ESV operators).

5-knots = 9.26 km/hr = 2.57 meters/second

For ultra-high performance antennas in use at 6 GHz, the duration of ESV presence in the FS main-beam is as follows:

Antenna Size	Beamwidth (3 dB)	ESV Time in the main FS beam
6-foot	1.8 deg.	20 seconds
8-foot	1.6 deg.	17 seconds
10-foot	1.3 deg.	14 seconds

As can be seen in the above best-case example, in all cases the ESV significantly exceeds the 2-second CGA outage point discussed in the author's April 10 Engineering Statement. As the FS antenna is moved back from the shore, and/or the ESV moves farther out to sea, and/or the ship approaches the microwave path at other than 90 degrees, the interference duration becomes much longer. As a further example, a ship 15 miles from a 10-foot UHX FS antenna crossing perpendicular to the path will be in the 3 dB beamwidth of the FS antenna for 190 seconds. It will be in the 1/10th dB beamwidth for 65 seconds!

Another problem with Mr. Collins' short-term analysis is that ITU-R Recommendation SF.615-1 is very specific in that interference degradations due to emissions from earth stations and space stations must be applied to a 2500 km reference circuit system (50 hop system). A per-hop equivalent short-term requirement would be about 16 seconds. This is about the duration of a single outage in the "best ESV case" discussed above. Since FS paths are normally "staggered" in order to prevent interference from overshoot with frequency re-use, one could expect that different FS receivers will receive this interference at different times in many systems. Finally, as Mr. Collins has pointed out, there are already thousands of earth stations in place coordinated to the -131 dBw/4 kHz level. Therefore, these stations are already contributing to the system-wide short-term outage requirement, thereby reducing the ESV per-hop short-term interference requirement even more.

Finally, ITU-R F.696-2 defines short-term interference as follows: "Short-term interference is the interference due to the existence of anomalous propagation conditions, and typically consists of very high levels of interference which only occur rarely, and exist for short periods of time." Clearly, ESV interference does not fall under this definition. One can only conclude from the above that ESV interference cannot be considered as short-term interference events, and therefore the -131 dBw/4 kHz criteria is clearly inadequate.

Frequency Coordination for the ESVs

Mr. Collins apparently didn't understand the statement in the author's April 10th Engineering Statement concerning coordination of microwave FS stations in the Gulf of Mexico. To re-iterate, it was stated that Alcatel had a difficult time coordinating FS receivers against the existing fixed satellite transmitters in and around the Gulf. Only through proper placement of paths to ensure FS antenna discrimination was it possible to accomplish this. ESVs, of course, are not constrained by any particular "path," and can sail right through the FS antenna bore-site.

Non-Interference for Experimental Operations

Mr. Collins claims that there are no reported cases of interference. But the lack of documented interference reports is inadequate justification for allowing potentially destructive transmissions to continue. In order to associate system outages with a particular cause (especially in the case of a moving interference source), information must be available in advance that would allow a cause and effect relationship to be established. It is good engineering practice, and expected, that those conducting experimental operations in a particular area will establish liaison with all parties that could potentially be affected by the experiment, in advance, and provide specific operational details, including location, time of operation and contact information. Thus, potentially affected parties can be on the lookout for interference effects and, if a problem develops, immediate coordination can be initiated to attempt to determine if the experimental activity is the cause. However, no potentially affected parties have ever been notified of the schedule when the experimental ESV operations would be conducted in their areas. Therefore, Fixed Service providers receiving interference for brief periods would have no way of suspecting that the source might be a passing experimental shipboard transmitter. Nor is there any indication of subsequent publication of activity logs, correlating time and location, so that where fixed service outage records might still be available, fixed operators could connect unexplained difficulties with ESV operations.

Interference Testing and Identification

Mr. Collins argues that MTN has offered to conduct cooperative testing to determine whether ESV operations cause excessive interference. But this is impossible to accomplish in a field environment because users cannot turn off their FS systems to monitor for ESV interference. Furthermore, it is very expensive to provide field personnel and test equipment. Clearly, the burden of proof should fall to the ESV operators to show that they will not cause interference, rather than to the FS users to prove that they are experiencing interference.

On the other hand, interference testing is very easy to do in a lab environment. Whether a -131/-154 dBw/4 kHz interfering signal is injected into the wave guide of an

FS receiver in the field, or injected into the antenna port of a microwave receiver in the lab, has no impact on the result of the test. It will be exactly the same in both cases. See the attached C/I curves.

Petitioners' Proposed interference Protection Objectives

Mr. Collins argues that the interference objectives previously proposed (-170 dBW/4kHz) are too strict, and "akin to those that are used to protect radio astronomy". As Mr. Collins surely knows, the proposed interference standards are those supported in TIA Bulletin 10F, and are the interference standards required for proper fade margin protection of digital receivers. Most organizations recognize that the analog -154/-131 dBw/4 kHz are not appropriate for digital receivers. If they were, the FS would be coordinating digital systems against each other using this much less stringent criteria.

The necessity of the more stringent digital criteria is actually required through FCC Part 25.251 (b) which states that "The technical aspects of coordination are based on Appendix 28 (now ITU-R, Volume 2, Appendix S7) of the International Telecommunications Union Radio Regulations...". Appendix 28, Section 2.3.1, Note 2 states "For digital radio-relay systems operating below 10 GHz, long-term interference power should not decrease the receiver fade margin by more than 1 dB. Thus the long-term interference power should be about 6 dB below the thermal noise power...". Assuming a typical FS receiver noise figure of 4 dB, the above statement indicates a long-term interference level of -170 dBw/4 kHz.

In the case of short-term interference, Appendix 28, Section 2.3.1, Note 3 does permit short-term interference to equal the fade margin of the FS receiver. This, of course, implies that the FS receiver will frequently experience a loss-of-frame when this level of interference occurs. Remember, however, this is the total short-term interference time on a 50-hop ITU-R digital reference circuit, which equates to about 16 seconds per hop per year. As pointed out earlier, the ESV interference cannot be considered to be short-term interference.

Finally, ITU also has an overall interference position. ITU-R F.1094 "Maximum allowable error performance and availability degradation to digital radio-relay systems arising from interference from emissions and radiations from other sources", states that: "In cases where digital radio relay systems are interfered with, the interfering radiation should not degrade the error performance or availability by more than one tenth of the percentage of the time allowed for the overall error performance degradation of the radio-relay system (ref. Rec. ITU-R SF.615)". This suggests that the maximum permissible budget for all interfering sources is 10% of the allowable degradation from all normal propagation effects. Thus, if the design requires 99.999% availability or 0.001% unavailability, then the interference (long-term and short-term combined) should not cause more than 0.0001% unavailability (31.5 seconds per year). Public safety hops are frequently engineered for 99.9999% availability, implying that unavailability from all interference should be less than about three seconds per year per hop.

Conclusion

The arguments put forth by MTN and Mr. Collins are flawed. They down-play this author's theoretical analysis, yet use theory to try to prove their own points. In addition, the assumptions used in their theory are incorrect. They assume a single-point, almost instantaneous, interference case, whereas the interference duration is significant. They also apply the short-term criteria to a single hop when these criteria must be allocated over an entire system. In contrast, this author can both calculate and demonstrate the levels of interference that will disrupt an FS digital receiver, as shown in this Supplemental Engineering Statement and in the attached C/I curves.

The compromise -145 dBw/4 kHz proposed by Mr. Collins is unacceptable for all the reasons stated in this Supplemental Engineering Statement and in the author's April 10 Engineering Statement filed earlier in this proceeding. Further, while Comsearch may agree with the -145 dBw/4 kHz for analog receivers, Comsearch does not agree with this criteria for digital receivers.

In other words, digital criteria are required to properly protect a digital FS receivers, and, the FS does use such criteria when coordinating FS digital paths. The FS is able to accomplish this through frequency avoidance and antenna discrimination. However, there is a major problem coordinating with satellite earth stations using frequency avoidance because they coordinate full-band, even though they don't need it. As an example, the ESV coordinations have sought all available frequencies even though a maximum of only 3 MHZ of spectrum is required. And, of course, FS antenna discrimination is not possible because of the mobile nature of the ESV. Furthermore, the ESV dock-side coordinations have also sought all available frequencies, though they only require 3 MHZ maximum spectrum and the ships are supposedly in port less than 20% of the time. In today's congested frequency environment, this appears to be a blatant case of spectrum warehousing.

The engineering facts support only one conclusion: ESV operations are causing interference and will continue to do so if the -131 dBw/4kHz criterion is used. If the number of ESVs increase, the incidence of interference will increase. Again, proving that the interference is due to ESVs will be impossible. The biggest problem in detecting ESV interference is that outages may not occur every time, even at the -131 dBw/4 kHz level. Normal path scintillation will result in paths sometime being slightly higher than normal, as well as sometimes lower than normal. At normal receive signal level and lower, -131 dBw/4 kHz will cause an outage on a typical hop. ATPC-equipped radios will always suffer an outage at this level. However, when the receive signal level is a little higher than normal, an outage may not occur. In any event, any ESV interference level greater than -170 dBw/4 kHz definitely will reduce the availability of an FS digital receiver.

In conclusion, the mixing of mobile and fixed services within the same frequency band cannot be successful unless proper interference criteria are applied. These interference criteria must be based on science, mathematics and sound engineering practices, not wishful thinking on the part of the ESV proponents.

M. Philip Salas

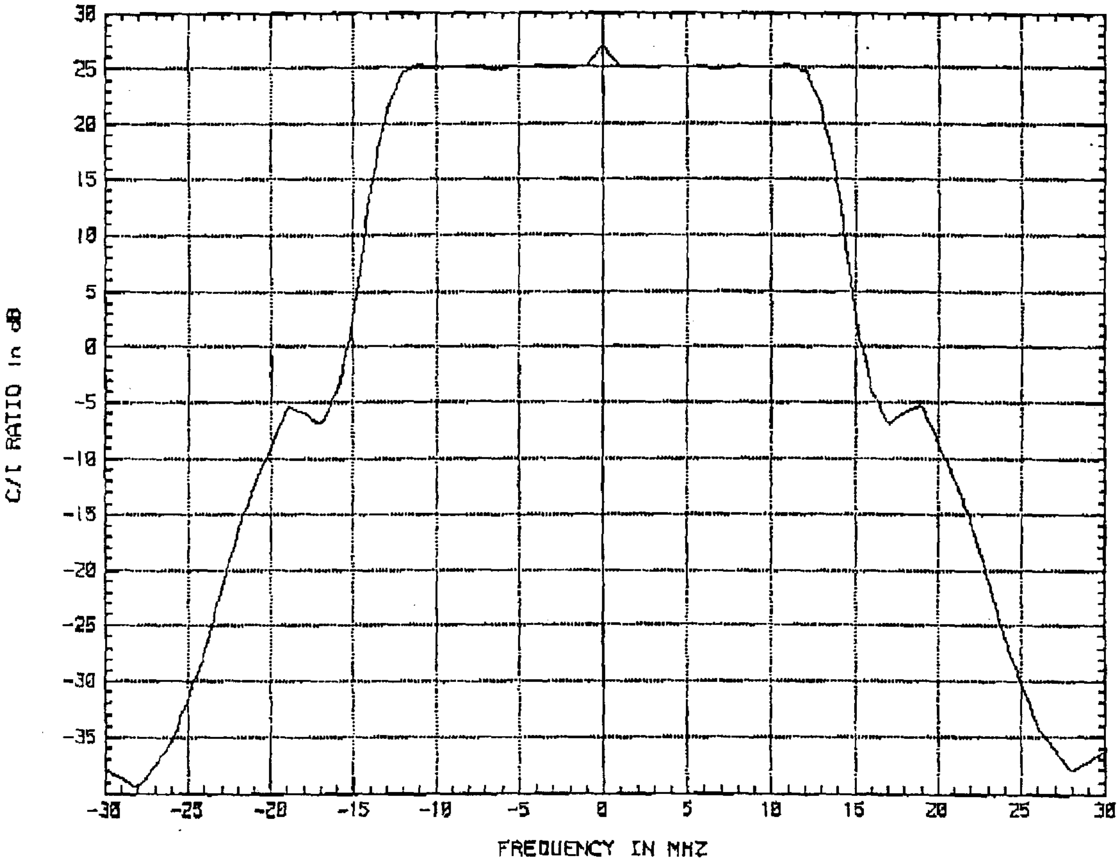
M. Philip Salas
Senior Manger
Alcatel USA

June 14, 2000

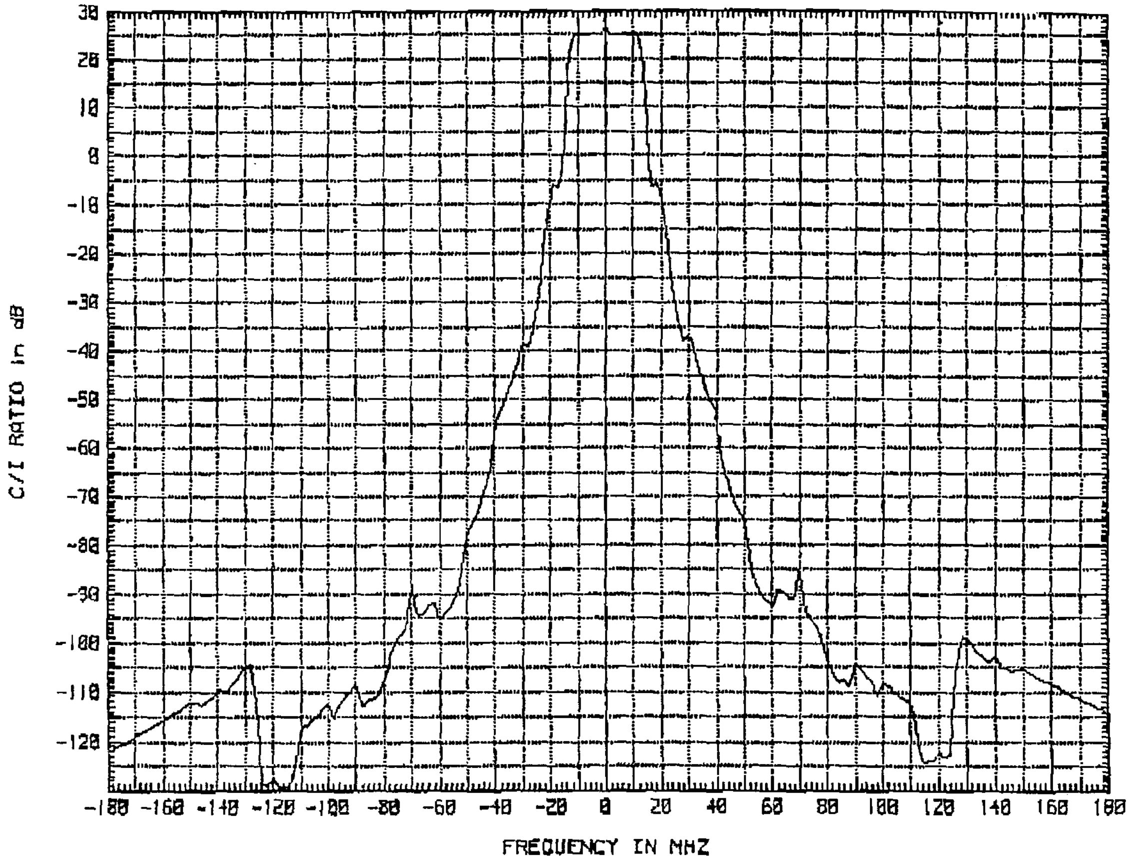
Attachments (6 pages)

	INTERFERING TRANSMITTER	VICTIM RECEIVER
RADIO NAME:	CW TONE	MDR-4306s-D
MANUFACTURER:	n/a	ALCATEL NETWORK SYSTEMS
MODULATION:	CW TONE	DIGITAL

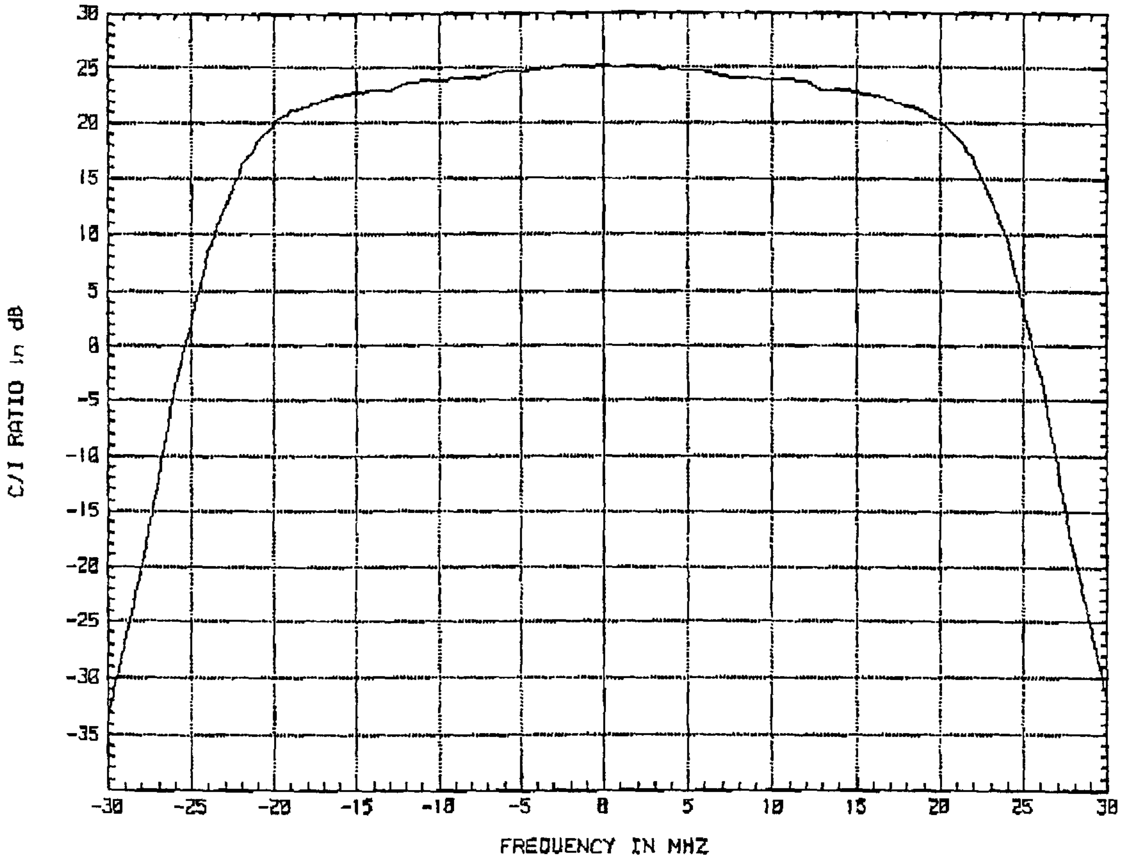
RF FREQUENCY RANGE: 5925 - 6425 MHz
BIT ERROR RATE: 10-6



	INTERFERING TRANSMITTER	VICTIM RECEIVER
RADIO NAME:	CW TONE	MDR-4306s-D
MANUFACTURER:	n/a	ALCATEL NETWORK SYSTEMS
MODULATION:	CW TONE	DIGITAL
RF FREQUENCY RANGE:	5925 - 6425 MHz	
BIT ERROR RATE:	10-6	

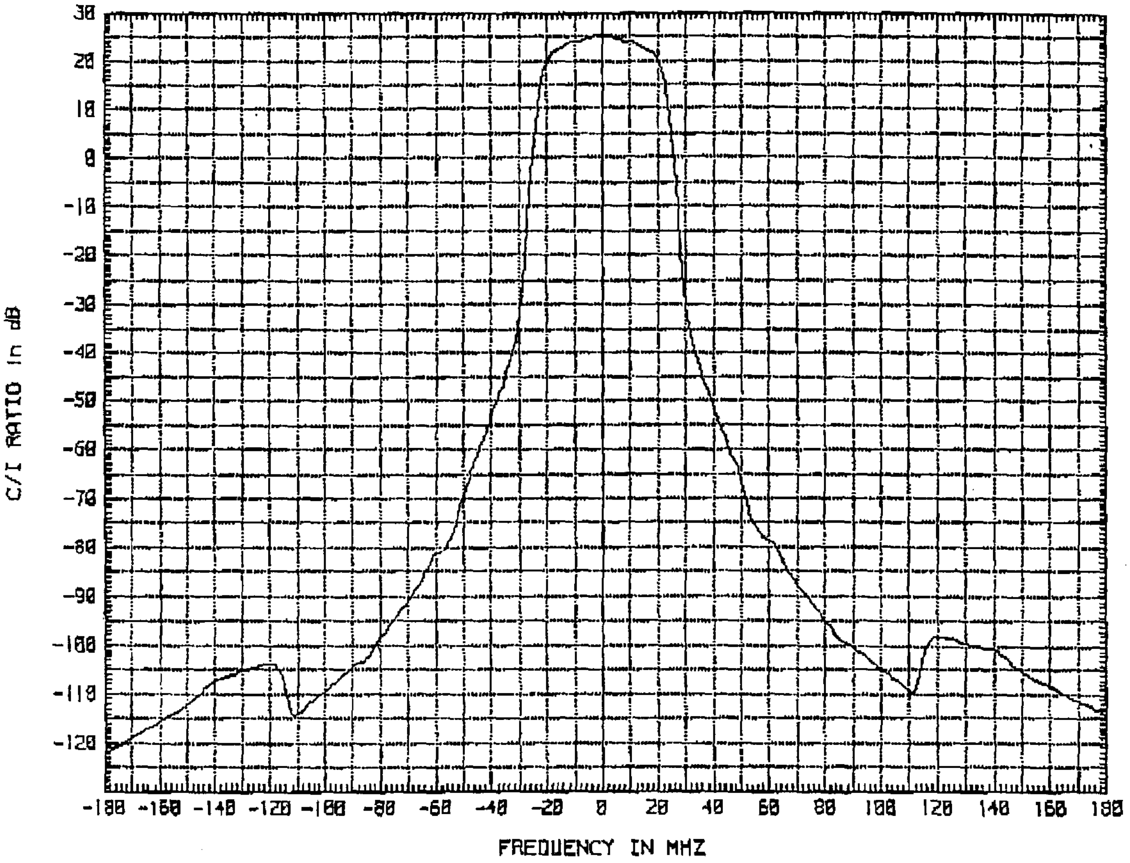


	INTERFERING TRANSMITTER	VICTIM RECEIVER
RADIO NAME:	MDR-4306s-D	MDR-4306s-D
MANUFACTURER:	ALCATEL NETWORK SYSTEMS	ALCATEL NETWORK SYSTEMS
MODULATION:	DIGITAL	DIGITAL
RF FREQUENCY RANGE:	5925 - 6425 MHz	
BIT ERROR RATE:	10-6	



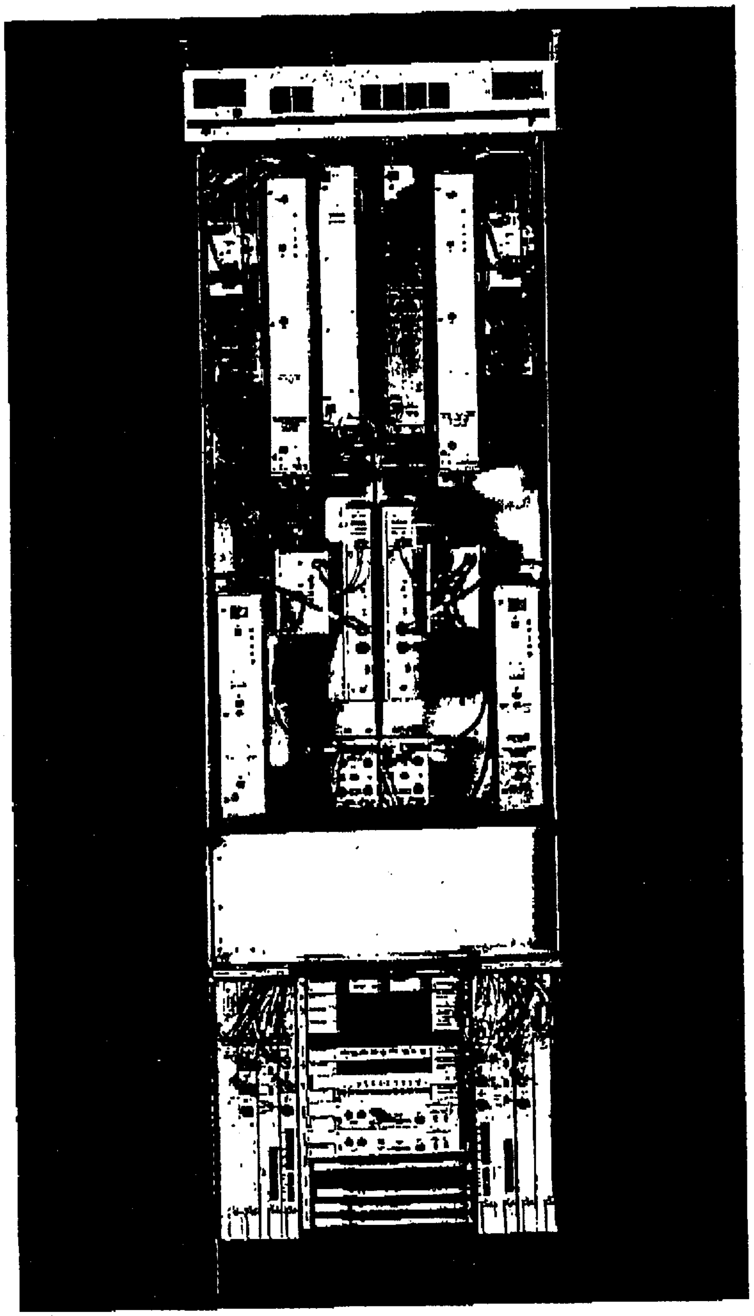
	INTERFERING TRANSMITTER	VICTIM RECEIVER
RADIO NAME:	MDR-4306s-D	MDR-4306s-D
MANUFACTURER:	ALCATEL NETWORK SYSTEMS	ALCATEL NETWORK SYSTEMS
MODULATION:	DIGITAL	DIGITAL

RF FREQUENCY RANGE: 5925 - 6425 MHz
BIT ERROR RATE: 10-6



6-GHz High-Capacity Digital Radio

MDR-4X06e



Features

- ▼ Capacities to fit your needs:
  - 1, 2, and 3 DS3s
- ▼ In-service capacity upgrades
  - From 1 to 2 DS3s
  - From 2 to 3 DS3s
  - From 1 to 3 DS3s
- ▼ Wayside DS1 lines
- ▼ Superior dispersive fade margins
  - Standard decision-feedback time domain equalizer
  - Standard adaptive IF slope equalizer
- ▼ Forward error correction (64 QAM)
- ▼ Errorless receiver switching
- ▼ Link monitor channel
- ▼ 4 x 64 kb/s service channels
- ▼ Automatic transmit power control
- ▼ Regenerative repeater configuration
- ▼ Two-year warranty
- ▼ Upgradeable to SONET transport

ALCATEL
NETWORK SYSTEMS

Technical Summary

	MDR-4106e-A	MDR-4106e-C	MDR-4206e-A	MDR-4206e-CN	MDR-4306e-C
Frequency band (GHz)	5.9-6.4	5.9-6.4	5.9-6.4	5.9-6.4	5.9-6.4
Emission designator	15M0D7W	10M0D7W	30M0D7W	20M0D7W	30M0D7W
Emission bandwidth (MHz)	15	10	30	20	30
Capacity/RF channel (Mb/s)	45	45	90	90	135
DS1 wayside line capacity	1	1	2	2	3
Modulation (QAM)	16	64	16	64	64
Data efficiency (b/s per Hz)	3.1	4.9	3.1	4.9	4.9
Data rate (Mb/s)	47.096	48.84	94.192	97.68	146.52
FCC identifier	JF6-9431	JF6-8803	JF6-8801	JF6-9214	JF6-8814
System gain[1,2] (BER = 10^{-3})					
Standard SSPA (dB)	112.5	108.0	109.5	105.0	102.5
Medium-power SSPA (dB)	114.5	110.0	111.5	107.0	104.5
High-power SSPA (dB)	117.5	112.0	114.5	109.0	106.5
Transmit frequency stability	0.001%	0.001%	0.001%	0.001%	0.001%
Transmitter power output[1]					
Standard SSPA (dBm)	30	29	30	29	29
Medium-power SSPA (dBm)	32	31	32	31	31
High-power SSPA (dBm)	35	33	35	33	33
Receiver threshold[1,2]					
BER = 10^{-3}					
Typical (dBm)	–82.5	–79.0	–79.5	–76.0	–73.5
Guaranteed (dBm)	–80.0	–76.5	–77.0	–73.5	–71.0
BER = 10^{-6}					
Typical (dBm)	–79.0	–76.5	–76.0	–73.5	–71.0
Guaranteed (dBm)	–76.5	–74.0	–73.5	–71.0	–68.5
Dispersive fade margin (BER = 10^{-3}) (dB)	57	58	51	50	46
Threshold/Interference					
Cochannel (dB)	27	34	27		34
Adjacent channel[3] (dB)		–50	–43		–28
Power consumption[4] (watts)					
Hot-standby terminal	250	255	260	265	270
Frequency diversity terminal	280	285	285	290	300

[1] Typical as measured at antenna port of branching circulator (includes branching losses).

[2] Hot-standby configurations (without space diversity) will have 0.5 dB less receiver threshold and system gain on the A side, and 10 dB less receiver threshold and system gain on the B side.

[3] All IF amplifiers have 30 MHz bandwidth. Special narrowband versions can be provided.

[4] Nominal without APC active (full transmit power), standard PA.

NOTE: These specifications are subject to change without notice.

ALCATEL
NETWORK SYSTEMS

1225 N. Alma Road
Richardson, Texas 75081-2206
Tel: 1-800-ALCATEL • Fax: 1-214-996-5409

523-0619335-301A3J, 9-29-95, Printed in USA

CERTIFICATE OF SERVICE

I, Deirdre A. Johnson, a secretary for the law firm of Verner,Liipfert, Bernhard, McPherson, and Hand, Chartered, hereby certify that I have this 15th day of June, 2000, caused a copy of the foregoing "**Reply to Opposition**" to be sent, via First Class, United States Mail, postage prepaid to each of the following:

Dale N. Hatfield
Chief
Office of Engineering and Technology
Federal Communications Commission
445 12th Street, S.W. – Room 7-C155
Washington, D.C. 20554

Bruce A. Franca
Deputy Chief
Office of Engineering and Technology
Federal Communications Commission
445 12th Street, S.W. – Room 7-C153
Washington, D.C. 20554

Donald Abelson
Chief
International Bureau
Federal Communications Commission
445 12th Street, S.W. – Room 6-C750
Washington, D.C. 20554

Steven Spaeth
International Bureau
Federal Communications Commission
445 12th Street, S.W. – Room 6-B434
Washington, D.C. 20554

Ari Fitzgerald
International Bureau
Federal Communications Commission
445 12th Street, S.W.
Washington, D. C. 20554

Thomas P. Stanley
Office of Engineering and Technology
Federal Communications Commission
445 12th Street, S.W. – Room 3-C460
Washington, D.C. 20554

Sylvia T. Lam
Engineer, Satellite Engineering Branch
Satellite and Radio Communication
Division
International Bureau
445 12th Street, S.W.
Washington, D.C. 20554

William T. Hatch
Associate Administrator
Office of Spectrum Management
NTIA
14th & Constitution Avenue, N.W.
Washington, D.C. 20230

Helen E. Disenhaus, Esq.
Eliot J. Greenwald, Esq.
Swidler, Berlin et al.
3000 K Street, N.W.
Suite 300
Washington, D.C. 20007

Deirdre A. Johnson