band at 1541.5-1547.5 MHz.[148] For carriers within the 1541.5-1547.5 MHz sub-band, our original PFD limits for ATC base stations at the edges of waterways of -64.6 dBW/m$^2$/200 kHz, summed over all carriers in a sector, will remain in effect.

65. We also agree with MSV that the dual requirements of PFD limits and physical separations of ATC base stations from airports and waterways is unnecessary. The separation distance we established provides a critical additional protection for safety services, according to Inmarsat.[149] While we recognize this argument, the determinative factor in preventing interference to METs is PFD, not separation. Therefore, we will eliminate the distance requirements in the rules, and require only that ATC base stations meet the PFD limits in the rules. Compliance may be demonstrated by either actual measurement of PFD at the edge of the airport or waterway, or by calculations using free-space loss.[150] The separation distances remain a good general indicator of necessary distances for design purposes. We also note ARINC/ATA's observation that there is no need for ATC base stations within 470 meters of an airport, because airports are generally free of obstructions and MSS satellites should be in view at all times. This factor, however, is more appropriate as a system design consideration. Our PFD requirement remains the critical factor in preventing harmful interference.

### 3. Overhead Gain Suppression

66. We grant MSV's request that we increase the overhead gain limits by 10 dB in elevation angles from 55° to 145° and by 8 dB in elevation angles from 30° to 55°. We agree with MSV's claim that ATC base stations can operate with 10 dB more gain in elevation angles from 55° to 145° and 8 dB more gain in elevation angles from 30° to 55° without causing an increase in interference greater than 0.3 dB based upon the aggregate interference model used in the *MSS Flexibility R&O* Technical Appendix.[151]

67. We find that MSV is correct in its assertion that the increases in overhead gain limits it requests will cause only a minimal increase in interference to co-primary MSS operators. We note that Inmarsat states that the overhead gain limits in the *MSS Flexibility R&O* were based on MSV's own statement that it would use a "specially designed antenna" that would perform to the specifications in its application for ATC authority, and that Inmarsat previously commented that MSV was unlikely to achieve these specifications.[152] We find this argument unpersuasive in light of the fact that an increase in interference of 0.3 dB is negligible. In measuring interference, a difference of 0.3 dB is difficult to measure, and in any event is highly unlikely to be a significant rise in interference. We find that there is no serious threat of harmful interference in relaxing the overhead gain suppression limits as requested by MSV, and therefore grant the request.

[148] We base this PFD calculation for waterways for the band 1541.5-1547.5 MHz on the following parameters: a n Inmarsat terminal receive gain of 7.5 dBi, a polarization isolation of 8 dB, a frequency of 1544.5 MHz and an interference tolerance level of -52 dBm.

[149] Noting that Inmarsat METs aboard aircraft are part of a safety service, Inmarsat explains that the PFD limits quantify the level at which aircraft METs will experience harmful interference, but that PFD limits can be difficult to measure accurately. *See* Inmarsat *Opposition* at 18-19.

[150] 47 U.S.C. § 25.253. *See* Appendix B.

[151] MSV asserts that the benefit of the overhead gain suppression levels we adopted in the *MSS Flexibility R&O* is far outweighed by the cost of implementing these levels of overhead gain suppression. *See* MSV *Petition* at 19-20; MSV *Reply* at 8.

[152] Inmarsat argues that the standards derived from analyses of overhead gain suppression that relied on MSV's statements cannot be changed without further detailed study. *See* Inmarsat *Opposition* at 17-18.

### 4. Protection of the Radionavigation Satellite Service

68. Background. In the *MSS Flexibility R&O*, we considered the need to protect reception of Radionavigation Satellite Service (RNSS) signals in the1559-1610 MHz band from out-of-band interference from ATC transmitters.[153] We decided that ATC mobile terminals and base stations should operate in compliance with the same limits on emissions in the 1559-1610 MHz band that we had previously prescribed for MSS METs in the *Global Mobile Personal Communications by Satellite (GMPCS)* proceeding.[154] MSS terminals transmitting on assigned frequencies in the 2 GHz MSS band must limit the EIRP density of out-of-band emissions in the 1559-1610 MHz frequency range to -70 dBW/megahertz or less averaged over two milliseconds of active transmission; and must limit the EIRP of discrete emissions of less than 700 hertz bandwidth in the 1559-1610 MHz band to -80 dBW, also averaged over two milliseconds.[155] Similar out-of-band emission limits apply to operation of Big LEO MSS terminals and MSS terminals transmitting on assigned frequencies in the 1626.5-1660.5 MHz band.[156] We accordingly adopted rule provisions that likewise require ATC handsets and base stations to meet an EIRP density limit of -70 dBW/megahertz and a narrowband EIRP limit of -80 dBW on out-of-band emissions in the 1559-1610 MHz RNSS band.[157]

69. Prior to our adoption of the *MSS Flexibility R&O*, NTIA stressed that the out-of-band emission limits adopted in the *GMPCS* proceeding were devised to protect aircraft reception of RNSS signals and contended that stricter limits should be imposed on ATC transmitters in order to protect ground-based RNSS receivers as well.[158] We noted in this regard that MSV had reached an agreement with the GPS Industry Council, in which it promised to limit the EIRP density from its proposed ATC base stations to -100 dBW/megahertz in the 1559-1605 MHz band, and limit the EIRP density of emissions in that band from ATC handsets to -90 dBW/megahertz.[159] NTIA provided a technical analysis proposing out-of-band emission levels that were consistent with those agreed to by MSV and the GPS Industry Council.[160] We did not, however, adopt NTIA's proposed out-of-band emission levels for L-band ATC base stations and mobile terminals because we disagreed with certain assumptions made in its analysis.[161] Although we recognize that NTIA disagreed with our assessment of its technical analysis, we declined to adopt stricter RNSS-band emission limits for ATC transmitters than we had previously

---

[153] *See MSS Flexibility R&O* at 2028-29, ¶¶ 124-126; 2051-53, ¶¶ 180-184. The RNSS includes the Global Positioning System (GPS) operating in a portion of the 1559-1610 MHz band. *See MSS Flexibility R&O* at 2028, ¶ 124.

[154] *See Amendment of Parts 2 and 25 to Implement the Global Mobile Personal Communications by Satellite (GMPCS) Memorandum of Understanding and Arrangements (GMPCS Order)*, IB Docket No. 99-67, Report and Order and Further Notice of Proposed Rulemaking, 17 FCC Rcd 8309 (2002) (modified in *GMPCS*, Second Report and Order, IB Docket No. 99-67, 18 FCC Rcd 24423 (2003)).

[155] *See* 47 C.F.R. § 25.216(e).

[156] *See* 47 C.F.R. § 25.216(a)-(d), (f)-(h).

[157] *See* 47 C.F.R. §§ 25.252(a)(7), (b)(3); 25.253(a)(6), (c)(7); 25.254(a)(4), (b)(4).

[158] *See MSS Flexibility R&O* at 2029, ¶ 125.

[159] *See id.* at 2053, ¶ 184. Further, MSV promised that the EIRP density of ATC handsets activated five years or more after the commencement of its proposed ATC operation would be limited to -95 dBW/megahertz in the 1559-1610 MHz band.

[160] *See* letter from Fredrick R. Wentland, Acting Associate Administrator, Office of Spectrum Management, NTIA, to Donald Abelson, Chief, International Bureau, FCC, IB Docket 01-185 (dated Nov. 12, 2002).

[161] For example, we did not agree that a 3 dB allowance for base station interference allotment for aviation GPS receivers was necessary. We also were not persuaded to establish interference standards based on a two meter separation distance.

adopted for MSS terminals in the *GMPCS* proceeding, however, because we did not find a sufficient basis in the record to support adoption of such stricter limits.[162] We stated that we planned to consider possible changes in our protection requirements for RNSS in a future rulemaking proceeding.[163] The GPS Industry Council filed a Petition for Reconsideration urging the Commission to amend the ATC rules to require all L-band ATC transmitters to operate within the stricter out-of-band emissions limits that MSV has agreed to meet.[164]

70. Discussion. We do not act on the GPS Industry Council's petition at this time. While we agree with the GPS Industry Council, NTIA, and other government agencies that it is essential to ensure that GPS does not suffer harmful interference,[165] it is also important to ensure that new technologies are not unnecessarily constrained. In this regard, we recognize that the President's new national policy for space-based positioning, navigation, and timing (PNT) directs the Secretary of Commerce to protect the radio frequency spectrum used by GPS and its augmentations through appropriate domestic and international spectrum management regulatory practices.[166] The PNT policy also directs the Secretary of Commerce, in cooperation with the Chairman of the FCC, to take the appropriate and legally permissible actions required to mitigate interference to GPS. Furthermore, the President's PNT policy calls for the establishment of an inter-agency Executive Committee, on which the Chairman of the FCC will be invited to participate as a liaison, and a National Space-Based PNT Coordination Office. It is our intention to establish discussions with other agencies, through the PNT Executive Committee and Coordination Office as appropriate, to better understand what protection levels for GPS are warranted. The results of those discussions may lead to future rulemaking proposals in order to ensure that all FCC services provide adequate protection to GPS, and produce a more complete record upon which to establish final GPS protection limits for MSS ATC licensees.

71. In the interim, the only MSS/ATC licensee, MSV, has agreed to comply with the tighter limits requested by the GPS Industry Council, and we have made compliance with these limits a condition of its license. If MSV requests a change to this condition, we will initiate a notice and comment period, and coordinate any change with NTIA and other government agencies. If additional ATC applications are filed, we will coordinate any ATC authority grant with NTIA, pursuant to the general notification process, to assure adequate protection of the GPS.

72. On our own motion, we amend the RNSS-band emission limits for ATC handsets and base stations in sections 25.252-25.254 to eliminate several minor, unintended discrepancies between those limits and corresponding emission limits in sections 25.216, in keeping with our previously stated intention to limit ATC emissions in the 1559-1610 MHz band to the same extent as emissions from MSS terminals.[167] We also amend section 25.216(i) pertaining to carrier-off-state emissions to delete language

[162] *See id.* at 2029, ¶ 126; 2052-53, ¶ 182.

[163] *See id.* at 2029, ¶ 126; 2053, ¶ 184.

[164] The GPS Industry council states that these stricter limits were broadly supported and endorsed by NTIA, and asserts that we must make decisions based on the facts in the record, and must "articulate a satisfactory explanation for [our] action including a rational connection between the facts found and the choice made." *See* GPS Industry Council *Petition* at 3-4 (quoting *Motor Vehicle Mfrs. Assn. v. State Farm Mutual Auto. Inc. Co.*, 463 U.S. 29, 43 (1983); *Citizens to Preserve Overton Park, Inc. v Volpe*, 401 U.S. 402, 416 (1971)).

[165] *See id.* at 4. *See also* ARINC/ATA *Comments* at 2-3; Delta Airlines *Comments* at 1-2.

[166] *See* U.S. Space-Based Positioning, Navigation, and Timing Policy, December 15, 2004, Fact Sheet, available on the World-Wide Web at www.ostp.gov/html/FactSheetSPACE-BASEDPOSITIONINGNAVIGATIONTIMING.pdf.

[167] These discrepancies arose because the MSS terminal limits in sections 25.216 were revised in some respects after the adoption of the ATC rules. In order to correct these discrepancies, we will amend sections 25.252, 25.253, and 25.254 to specify measurement intervals as two milliseconds in place of the current 20 milliseconds, change the

(continued....)

that is inconsistent with our intention that the limit should restrict average EIRP density.[168] Because this amendment is merely clarifying, rather than substantive, prior public notice and comment is unnecessary.

### 5. Protection of Search-and-Rescue Satellite Service (SARSAT)

73. We deny a request from MSV to change the language defining coordination zones around SARSAT earth stations. In the *MSS Flexibility R&O*, we required ATC providers to "provide the Commission with sufficient information to complete coordination of any ATC base station placed within 27 km from one of the [SARSAT earth station locations] and within the radio horizon of the SARSAT earth station prior to operation."[169] MSV claims that this language could be confusing, and requests that we amend the rules so that this requirement is "for any ATC base station located within 27 km of a SARSAT and within radio horizon of the SARSAT station [sic]."[170] No other party addresses this issue.[171] We find this request to be without substance because MSV's proposed language has the same effect as the language currently in the rules.

### 6. Non-Forward Band Operation

74. We grant a request from MSV to clarify a note to section 25.253 that modifies the rule in section 25.149(a)(1) requiring operation in the forward-band mode.[172] The note to section 25. 253 states that our L-band technical rules are based on GSM/TDMA 800 or GSM 1800 system architecture, and that an L-band MSS/ATC operator may implement an alternate system architecture upon demonstrating that the alternate system architecture would produce no greater potential interference than the rules allow.[173] MSV requests that we clarify that the note to sections 25.253 applies to section 25.149(a)(1) so that an MSS/ATC applicant may implement a non-forward band system architecture upon demonstrating that such a system architecture will cause no greater interference than the rules permit.[174] We agree with MSV that L-band MSS operators should be able to implement a non-forward band system architecture if they demonstrate that such a system architecture will cause no greater interference to other MSS systems in the L-band than the rules permit.

---

(...continued from previous page)
permitted EIRP density of emissions in the 1605-1610 MHz band from ATC terminals and base stations operating in the L-Band, specified in section 25.253(d)(7) and (g)(3) from -10 dBW/megahertz to -46 dBW/megahertz, amend section 25.254(a)(4) to change the permitted EIRP density of emissions in the 1605-1610 MHz band from ATC base stations with assigned frequencies above 2483.5 MHz to -70 dBW/megahertz, establish narrowband EIRP limits in the 1605-1610 MHz segment for all ATC terminals, and prescribe stricter limits on EIRP density in the 1559-1610 MHz band for ATC terminals when in the carrier-off state.

[168] *See GMPCS*, Second Report and Order, IB Docket No. 99-67, 18 FCC Rcd 24,423, 24,455-56, ¶ 97 (2003).

[169] *MSS Flexibility R&O* at 2049-50, ¶ 177.

[170] MSV states that this requirement was intended to require coordination only when the planned ATC base station was both within 27 km of a SARSAT earth station and within the radio horizon of the SARSAT earth station, but notes that the rule itself applies this requirement to any planned ATC base station "located either within 27 km of a SARSAT station, or within the radio horizon of the SARSAT station, whichever is less." MSV *Petition*, Appx. E at 3.

[171] We note that the value of 27 km mentioned above is dependent on the EIRP of ATC base stations. MSV has requested a change in the base station EIRP. If the base station EIRP changes this value will also change.

[172] *See* MSV *Petition* at 23.

[173] *See* 47 C.F.R. § 25.253 at note.

[174] *See* MSV *Petition* at 23.

### D. Licensing Issues

#### 1. Assignment of Licenses by Competitive Bidding

75. Background. In the *MSS Flexibility R&O*, we concluded that under our decision to permit the grant of ATC authority to previously licensed MSS operators through the modification of their MSS authorizations, certain conditions for assigning licenses by competitive bidding pursuant to section 309(j)(1) of the Communications Act would not be met. Specifically, we found that our decision precluded the filing of mutually exclusive applications,[175] and that license modifications associated with ATC would not be modifications so different in kind or so large in scope as to warrant treatment as "initial" licenses subject to Section 309(j)(1).[176] We also concluded that allowing MSS operators to incorporate ATC without going through a competitive bidding process would not be inequitable to CMRS carriers or unjustly enrich MSS operators such that the modification of their authorizations should be treated as initial licenses.[177] We based this conclusion on the fact that we placed strict limitations on the ATC authority that would be available to MSS operators and the significant costs of launching and maintaining satellite operations.[178] We also found that restricting eligibility for ATC authority to licensed MSS operators was consistent with our obligations under Section 309(j)(3), which include promoting the deployment of new technologies and services in rural areas and ensuring efficient and intensive use of the spectrum.[179]

76. Cingular argues that the decision to award terrestrial rights to 2 GHz MSS licensees without an auction is contrary to Section 309(j) of the Communications Act and is wrong as a matter of law and policy.[180] More specifically, according to Cingular, the record demonstrates that segmentation of the spectrum would be more efficient than integrated MSS-terrestrial operations and therefore "an auction is compelled by statute."[181] In support of this assertion, Cingular cites a study by Telcordia Technologies (Telcordia), which Cingular states concluded that the spectrum efficiencies through dynamic frequency control claimed possible by MSS/ATC proponents were unlikely to be realized, that ATC would degrade MSS performance, and that any terrestrial use of MSS spectrum would probably be accomplished through band segmentation, in which case there would be no loss of efficiency if the terrestrial and satellite operations were performed by different parties.[182] Cingular also claims that the Commission's finding that MSS operators would not be unjustly enriched by its decision to make ATC authority available to them was unsupported and does not withstand scrutiny.[183]

---

[175] *See MSS Flexibility R&O* at 2068-69, ¶ 221.

[176] *See id.* at 2070, ¶¶ 224-225; 47 U.S.C. § 309(j)(1).

[177] *See MSS Flexibility R&O* at 2071, ¶ 226.

[178] *See id.* We also found that MSS operators with ATC authority would not compete directly with terrestrial CMRS. *See id.* at 2072, ¶ 229.

[179] *See id.* at 2071-72, ¶ 228 (citing 47 U.S.C. § 309(j)(3)(A) & (D)).

[180] *See* Cingular *Petition* at 1. Cingular also claims that the decision to award terrestrial rights to 2 GHz MSS licensees without an auction is contrary to "the FCC's decision in the licensing orders to allow 2 GHz MSS applicants to succeed or fail . . . on the basis of a satellite-only authorization," *See also* Cingular *Reply* at 2.

[181] *See* Cingular *Petition* at 2.

[182] *Id.* at 16-19.

[183] *Id.* at 22-23. *See also* letter from Brian F. Fontes, Vice President, Federal Relations, Cingular, to Marlene Dortch, Secretary, FCC, IB Docket 01-185 at 5 (dated Jan. 28, 2005). Section 309(j)(3)(C) states that the Commission shall seek to recover for the public "a portion of the value of the public spectrum resource made available for commercial use and avoidance of unjust enrichment through the methods employed to award uses of that resource." 47 U.S.C. § 309(j)(3)(C).

77. Discussion. We deny Cingular's request to assign ATC authority by competitive bidding. Contrary to Cingular's contention, the Telcordia study does not demonstrate that MSS/ATC frequency sharing is infeasible. Specifically, the study fails to consider techniques for reducing self-interference that MSV proposes to incorporate into its ATC system, and that other ATC providers could also employ. The Telcordia study concludes that band sharing between MSS and ATC, even with dynamic frequency sharing, will only permit the use of very few ATC handsets in very large areas, on the order of fewer than 100 handsets in areas larger than the State of Texas.[184] According to Telcordia and Cingular, band sharing is not feasible and band segmentation is the only means by which ATC can be provided in MSS bands. However, we also have before us studies and a plan that concludes that thousands or millions of ATC handsets can operate in the United States without causing harmful interference to MSS, including a highly developed plan from MSV for ATC in the L-band. This plan offers the possibility of MSS/ATC band sharing using dynamic frequency assignment. We have chosen to credit the analyses and plans showing that MSS/ATC band sharing is possible, because MSV's plan for ATC indicates that frequency sharing is possible without harmful interference. If Telcordia and Cingular are correct, there presumably will be no ATC, for we see little business sense in building an ATC to serve fewer than 100 handsets in an area larger than Texas. If, however, MSS/ATC proponents are correct, ATC will help to expand communications options to the American public and will use spectrum more efficiently and intensively.

78. Because we reject Telcordia's conclusion that the only means by which MSS/ATC can be accomplished is band segmentation, we are not persuaded that our decision to make ATC authority in the 2 GHz MSS band available only to previously licensed MSS operators was in error, and we again conclude that it would not be in the public interest to grant terrestrial rights in this band to entities other than MSS operators. We addressed Cingular's argument in favor of band segmentation and authorizing separate entities to provide MSS and terrestrial service in the *MSS Flexibility R&O*. There we stated that band segmentation would amount to reallocation of a portion of the MSS bands, and decided that such reallocation would be unreasonable and unwarranted.[185] Further, as we stated in our discussion of substantial satellite service,[186] MSS and ATC usage will vary by area of the country. Allocating some portion of the MSS bands for terrestrial use could cause those portions to be underused in rural and remote areas. Similarly, allocating some portion of the MSS bands exclusively for MSS use would continue the current situation, in which MSS is not available in some areas, particularly urban areas with significant blockage of the satellite communication path.

79. We conclude that band segmentation would not be an "efficient and intensive use of the electromagnetic spectrum."[187] Thus, we are not persuaded that we should make ATC authority available by means of a licensing process that permits the filing of mutually exclusive applications for initial licenses, and we affirm our conclusion in the *MSS Flexibility R&O* that our decision to permit MSS operators to acquire ATC authority does not establish the requisite conditions for assigning terrestrial licenses in the MSS bands through competitive bidding.

80. Cingular's argument regarding unjust enrichment also does not lead us to conclude that we should adopt a licensing process that would make ATC authority available to entities other than MSS operators. First, we find Cingular's argument that MSS operators would be unjustly enriched to be

[184] *See* letter from Brian F. Fontes, Vice President, Federal Relations, Cingular, to Don Abelson, Chief, International Bureau, FCC, IB Docket 01-185 at 2-3 and Attachment A (dated May 13, 2002).

[185] "The Commission has identified MSS as an important component of our overall mix of spectrum allocations. The "separate-band, separate-operator" approach, however, would, in essence, reallocate spectrum from MSS to other uses. We believe that reconsideration of the spectrum-management decision to allocate resources to MSS is unreasonable and unwarranted. . . ." *See MSS Flexibility R&O* at 1996, ¶ 58.

[186] *See supra* ¶ 20.

[187] 47 U.S.C. § 309(j)(3)(D).

flawed because it is based on a valuation of spectrum that is largely irrelevant to the heavily restricted ATC authority we authorized in the *MSS Flexibility R&O*. Second, we do not agree that the *Seventh CMRS Competition Report* includes "findings" that satellite operators are in direct competition with terrestrial wireless operators.[188] While that report includes satellite operators as "other types of operators that are competing in the mobile telephone segment,"[189] the discussion is merely a brief description of how satellite telephony works and the services and products offered. The text of the report makes clear that prices for satellite services, in particular handset prices, are not competitive with currently offered CMRS wireless plans; nor does the report extend the competitive analysis undertaken for CMRS providers (including discussions of churn, subscriber growth, market penetration, etc.) to satellite operators, as would be consistent with an assertion that these operators compete directly with terrestrial providers. Third, our decision to modify MSS operators' licenses to include ATC authority is consistent with other decisions in which the Commission has extended licensees additional operating rights without accepting competing applications that might have been mutually exclusive and required an auction.[190]

81. Finally, Cingular ignores the fact that we must consider and balance all of the objectives of Section 309(j)(3) in identifying classes of licenses to be auctioned, including "the development and rapid deployment of new technologies, products, and services for the benefit of the public, including those residing in rural areas"[191] and "efficient and intensive use of the electromagnetic spectrum. . ."[192] We concluded in the *MSS Flexibility R&O* that our decision to restrict terrestrial rights in the bands used by MSS operations to the provision of ATC by MSS operators only, and our concomitant decision not to accept terrestrial applications from other parties, is consistent with these goals.[193] Cingular's arguments do not persuade us that the objective of efficient, intensive spectrum use would be better served by band segmentation; nor has Cingular demonstrated how the other goals of Section 309(j)(3) such as the rapid deployment of services to rural areas would be better achieved by making terrestrial rights in the 2 GHz MSS band available to parties other than MSS operators. We therefore decline to reverse our decision to make ATC authority available to MSS operators through the modification of their MSS authorizations.

---

[188] *See* Cingular *Petition* at 23 (citing *Implementation of Section 6002(B) of the Omnibus Budget Reconciliation Act of 1993(Seventh CMRS Competition Report)*, Seventh Report, FCC 02-179, 17 FCC Rcd 12,985, 12997, 13025-28 (2002).

[189] *See Seventh CMRS Competition* Report at 13,025.

[190] *See, e.g., Amendment of the Commission's Rules to Permit Flexible Service Offerings in the Commercial Mobile Radio Services (CMRS Flexibility Report and Order)*, First Report and Order and Further Notice of Proposed Rulemaking, WT Docket 96-6, 11 FCC Rcd 8965, 8979-80, ¶ 33 (deleting footnotes US330 and US331, which prohibited PCS licensees from providing fixed service, without triggering the competitive bidding requirements of Section 309(j)); *Amendment of Parts 21 and 74 to Enable Multipoint Distribution Service and Instructional Television Fixed Service Licenses to Engage in Fixed Two-Way Transmissions*, MM Docket 97-217, 13 FCC Rcd 19,112 (1998), recon., 14 FCC Rcd 12,764 (1999), further recon., 15 FCC Rcd 14,566 (2000) (permitting both MDS and ITFS licensees to provide two-way services and increasing flexibility on permissible modulation types and channelization). In both the CMRS and MDS/ITFS context, the Commission did not consider accepting competing applications from non-incumbents because of the difficulties of coordinating new fixed uses with existing mobile uses in CMRS and coordinating fixed two-way transmissions with existing one-way uses in MDS/ITFS. Although we sought comment on the possibility of coordination with respect to MSS spectrum, we have concluded that, as in those prior cases, there is no practical means by which a new licensee could coordinate terrestrial uses with existing satellite rights in the spectrum. *See MSS Flexibility R&O* at 2070-71, ¶225.

[191] 47 U.S.C. § 309(j)(3)(A).

[192] 47 U.S.C. § 309(j)(3)(D).

[193] *See MSS Flexibility R&O* at 2071-72, ¶¶ 227-228.

### 2. Public Notice of Licensing Actions

82. We indicated in the *MSS Flexibility R&O* that applications for ATC authority that meet certain requirements will be treated as applications for minor modifications to the MSS license.[194] Inmarsat claims that this is a departure from past Commission practice and that a minor modification is one that does not have the potential to increase interference.[195] Inmarsat requests that all applications for ATC authority be open to public notice and comment, to provide the opportunity for affected parties to evaluate the applications and comment on them .[196] Further, Inmarsat requests that we require ATC licensees to notify us when they commence ATC operations, and issue a public notice to announce the start of the 18-month limited deployment period specified in the rules.[197] Inmarsat also requests that we require MSS/ATC operators to keep complete records of the locations of ATC base stations and the number of MSS/ATC handsets deployed, and to file that information with us every six months, to allow affected parties to be apprised of the scope of deployment.[198] Finally, Inmarsat requests that we place on public notice "any waiver requests made by an ATC operator after deployment of its ATC operations," arguing that any such waiver or modification of an ATC system could cause interference that was not considered in the *MSS Flexibility R&O.*[199]

83. In the *Sua Sponte Order*, we stated that "we require that the Commission place on notice for public comment any initial application for authority to add an ATC component to an eligible satellite network."[200] We therefore dismiss as moot Inmarsat's request that we make applications for ATC authority open to public notice and comment. We deny Inmarsat's request to issue a public notice at the start of the 18-month limited deployment period, and the request for specific information to be filed with us every six months. We have the authority to require MSS/ATC operators to file such information as we think necessary to evaluate the interference potential of ATC. We will seek analysis and comment from interested parties, and will make available to those parties the evidence needed to make their analyses and comments. It is impossible to determine at this point precisely what information will be necessary, and we therefore decline to require the filing of information that may not be necessary.

84. For the same reasons, we decline to adopt a rule requiring all waiver requests to be placed on notice for public comment. We agree with MSV's position that we should maintain the flexibility to decide whether waiver requests should be put on public notice individually, because some waiver requests may be innocuous, and inviting public comment would merely waste time.[201] Further, providing full notice and comment on minor or innocuous waiver requests would run the risk of allowing frivolous objections calculated merely to harass and delay ATC deployment. We will be able to determine those situations where public comment and the input of affected parties is needed. We are not persuaded that any useful purpose would be served by eliminating *ad hoc* discretion in this regard.

---

[194] *See* 47 C.F.R.§ 25.150(a)(3) and (a)(4).

[195] Inmarsat states that an "amendment will be deemed to be a major amendment. . . [i]f the amendment increases the potential for interference. . . ." *See* Inmarsat *Petition* at 19 (quoting 47 C.F.R. § 25.116(b)).

[196] *See id.* at 20-23.

[197] *See* 47 C.F.R. § 25.253(c).

[198] *See* Inmarsat *Petition* at 23-24.

[199] *Id.* at 24.

[200] *Sua Sponte Order* at 13,596, ¶ 14. *See also* 47 C.F.R. § 25.117(f).

[201] *See* MSV *Opposition* at 12.

### 3. Conditional Licenses

85. Boeing requests reconsideration of the *Sua Sponte Order*. Boeing states that we initially adopted licensing rules for ATC under which we would grant MSS operators seeking to offer ATC conditional authorizations that prohibited them from offering ATC prior to meeting ATC gating criteria and MSS implementation milestones.[202] Boeing argues that the approach taken in the *Sua Sponte Order* will not provide greater clarity, but will cause substantial uncertainty in the process of incorporating an ATC into an MSS network.[203] According to Boeing, the licensing system adopted in the *MSS Flexibility R&O*, on the other hand, allowed MSS operators to control the timing of their business plans by scheduling each step on the way to providing MSS and ATC to customers.[204] Boeing contends that administrative convenience is the only justification we offered for changing the licensing system, and claims that the new approach will not be easier to administer, because we will still accept applications submitted by MSS licensees that have not met the gating criteria, and then will have to review additional submissions demonstrating that each gating criterion has been met. To avoid inconvenience and uncertainty, as well as time-consuming delays, Boeing requests that we return to the licensing regime adopted in the *MSS Flexibility R&O*.[205]

86. We deny Boeing's request. We made it clear in the *Sua Sponte Order* that an MSS operator is prohibited from conducting commercial ATC operations until the operator has received authorization to do so. As we stated in that *Order*, granting ATC authorization "conditioned upon" meeting the gating criteria could be interpreted as meaning that we authorized the commencement of commercial ATC operations prior to satisfaction of all the gating criteria.[206] It is also possible that an MSS/ATC operator, in possession of a conditional authority, could begin commercial operations before all the gating criteria were met to our satisfaction. In such circumstances, customers could be deprived of service for which they had contracted if we found that the gating criteria had not been met and required the MSS/ATC operator to cease operations pending satisfaction of the gating criteria.

87. At the same time, we realize that the optimum time to begin ATC operations is as soon as the MSS system meets all the gating criteria, and that delays are harmful to the business operations of MSS/ATC operators. The licensing regime we adopted in the *Sua Sponte Order* recognized this and built in the flexibility to allow an MSS/ATC applicant that needs extra time for consideration of complex issues to seek a pre-authorization ruling that some gating criteria have been met.[207] We also provided the opportunity for a licensee to receive ATC authority upon a showing that our geographic and temporal coverage, replacement satellite, and commercial service criteria have been met, provided "the MSS ATC

---

[202] *See* Boeing *Petition* at 4-5. Under the approach we adopted in the *Sua Sponte Order*, according to Boeing, MSS operators will still be permitted to file applications for ATC authority before meeting all gating criteria, but we will not grant ATC authorizations until the MSS operator has demonstrated that it has met all of the gating criteria. We justified this change on the basis that such a system would be easier to administer and would provide a clear standard for when an MSS/ATC operator may begin commercial operations. *See id.* at 5-7.

[203] The process of reviewing and considering licenses applications can be long and complex, and we have offered only to endeavor to act on each application within 90 days, but made no guarantees. As a consequence, MSS operators will be unable to advise potential customers when ATC will be available, to the detriment of MSS service offerings, contends Boeing. *See id.* at 6-7.

[204] With conditional authority to offer ATC, MSS operators could even outline their ATC plans, demonstrating that each of the gating criteria would be met on a date certain, and ATC operations could then commence immediately upon meeting the gating criteria. *See id.* at 7-8.

[205] Multiple filings, each with its own set of comments and petitions in response to public notice, will make the licensing process complex and time consuming, argues Boeing. *See id.* at 8-9.

[206] *See Sua Sponte Order* at 13,594-95, ¶ 10.

[207] *See id.* at 13,593, ¶ 7.

applicant makes a satisfactory, prospective, substantial showing that its ATC operations will meet our integrated service and other gating criteria."[208] This amounts to the conditional authority Boeing requested, while at the same time ensuring that we maintain control of the authorizing process and that applicants show substantial progress toward meeting the gating criteria before receiving a grant of ATC authority. Beyond these limited circumstances, we decline to grant ATC authority to an applicant that has not yet met the gating criteria.

### 4. Demonstrations of Compliance

88. In the alternative, Boeing requests that we adopt an application approval process for non-operational MSS systems similar to the approach in the *Sua Sponte Order*. Specifically, we stated in the *Sua Sponte Order* that "we will grant ATC authority to an operating MSS system in actual compliance with our MSS system geographic and temporal coverage, replacement satellite, and commercial service gating criteria if the MSS ATC applicant makes a satisfactory, prospective, substantial showing that its ATC operations will meet our integrated service and other gating criteria."[209] Boeing contends that this provision allows operational MSS operators a streamlined approval process, while non-operational MSS operators will be handicapped by the time needed to construct and launch its satellite network, and by the delay of securing authority to provide ATC.[210] Boeing requests that we permit non-operational MSS operators able to make certain demonstrations that they will be within compliance with the gating criteria within one year.[211] Further, Boeing requests that we clarify how MSS operators can demonstrate that they have satisfied the gating criteria[212]

89. We agree with Boeing's argument that we should grant non-operational MSS applicants for ATC authority the opportunity to demonstrate that they will be in compliance with the gating criteria in the near future. We see no reason why an MSS operator should not be able to begin ATC operation at the same time it begins MSS operation. A non-operational MSS operator, like an operational MSS operator, is free to "without further authority from the Commission and at its own risk, engage in pre-operational build-out and conduct equipment tests" on an ATC.[213] It is subject to precisely the same conditions as an operational MSS operator, *i.e.*, it may not provide ATC service until its MSS system and ATC service meet our gating criteria. Therefore, we will grant a non-operational MSS operator the same sort of authority that we will grant operational MSS operators. Upon a satisfactory, prospective and substantial showing that a non-operational MSS licensee will soon meet the gating criteria, we will grant the MSS operator ATC authority to begin ATC operations upon actually meeting the gating criteria.

---

[208] *See id.* at 13,595, ¶ 11.

[209] *Sua Sponte Order* at 13,595, ¶ 11.

[210] *See* Boeing *Petition* at 10.

[211] The non-operational MSS operator making a "satisfactory, prospective and substantial showing that its ATC service will satisfy sections 25.149(b)(4) and (b)(5) of the Commission's rules" should be granted an ATC authorization conditioned on the operator coming into compliance with sections 25.149(b)(1) (geographic and temporal coverage), (b)(2) (replacement satellites), and (b)(3) (commercial availability).[211] Boeing states that we should allow impending satisfaction of geographic and temporal coverage requirements to be demonstrated by a submission of predicted antenna gain contours, replacement satellite requirements to be satisfied by submission of a contract or certification of a satellite manufacturer listing a scheduled completion date, and the commercial availability requirement by submission of letters from handset suppliers or from customers who have contracted for service. *See id.* at 11-13. *See also* C.F.R. § 25.149(b)(1) – (3).

[212] Specifically, Boeing requests that we clarify that the demonstrations it advocated can be used to satisfy the geographical and temporal coverage, replacement satellite, and commercial availability, and that a certificate of compliance from the MSS/ATC operator will satisfy the in-band operation requirement of section 25.149(b)(5) of the rules. *See* Boeing *Petition* at 18-19. *See also* 47 C.F.R. § 25.149(b)(5).

[213] 47 C.F. R. §§ 25.136(g), 25.143(j).

90. We decline, however, to grant the clarifications Boeing requests. Boeing's proposed demonstrations lack the specificity we intend to require. Terms such as "predicted spacecraft antenna gain,"[214] "arrangements for the construction of a replacement satellite,"[215] and "letters from its suppliers of user terminals, or letters from customers that have contracted for . . . services"[216] are too vague to be granted the status of conclusive demonstrations. We will require detailed showings in any case where an MSS/ATC applicant claims that it is near to meeting our gating criteria. Although all of the factors Boeing lists will be relevant to our review of applications and may be conclusive, we reserve the right to require additional detail and certainty. Therefore, we deny Boeing's requested clarification.

### E. Uplink Interference in the Big LEO Band.

#### 1. Out-of-Band Emissions

91. Inmarsat states that it raised concerns about potential interference to its L-Band MSS system from future deployment of ATC in the Big LEO band, and that we did not address this issue in the *MSS Flexibility R&O*. Inmarsat requests that we consider its earlier arguments and adopt out-of-band emissions limits for ATC in the Big LEO band to protect MSS systems in the adjacent L-band.[217]

92. We find that we adequately addressed the potential for out-of-band interference in the Big LEO uplink band in the *MSS Flexibility R&O*. Specifically, we adopted out-of-channel emissions limits of -44.1 dBW per 30 kilohertz for ATC base stations in the Big LEO band,[218] and -57.1 dBW per 30 kilohertz for handsets in the Big LEO band.[219] We consider these limits sufficient to protect Inmarsat's satellites in the superjacent 1626.5-1660.5 MHz band. We also note that Inmarsat's only reference to possible interference to L-band MSS from Big LEO band ATC was a single paragraph which claimed only that Big LEO band ATC could cause harmful interference to Inmarsat's MSS in the L-band.[220] Because we adequately addressed the potential for out-of-band interference from ATC in the Big LEO band, we deny this request.

#### 2. Protection of Broadcast Auxiliary Service

93. SBE requests that we reconsider the decision to allow ATC base stations in the Big LEO band. In the *MSS Flexibility R&O*, we noted that some Broadcast Auxiliary Service (BAS) operations are permitted on BAS Channel A10 (2483.5-2500 MHz) on a "grandfathered" basis, but stated that the records indicate that there are no BAS facilities licensed in this band. SBE points out that there are 87 licenses currently authorized for BAS Channel A10, according to our Universal Licensing System, though ten of these licenses are listed as "expired" or "cancelled."[221] SBE requests that we reconsider the decision to allow ATC in the Big LEO band to protect BAS Channel A10 operations. In the alternative, SBE requests that we require any Big LEO MSS operator that seeks authority to operate ATC to pay the reasonable costs of converting BAS equipment to digital operation on three narrower channels in what are

[214] Boeing *Petition* at 15.

[215] *Id.* at 17.

[216] *Id.* at 18.

[217] *See* Inmarsat *Petition* at 15.

[218] *See* 47 C.F.R. § 25.254(a)(2).

[219] *See* 47 C.F.R. § 25.254(b)(3).

[220] *See* Inmarsat, *Comments of Inmarsat Ventures PLC* 20-21 (dated Oct. 19, 2001) (in response to the *MSS Flexibility NPRM*).

[221] *See* SBE, *Petition for Reconsideration (Petition)* at 1-2.

currently BAS Chan A8 and A9.[222]

94. We wil e measures to protect licensees on BAS Channel A10. The number of ac e BAS Channel A10 users is sufficiently smal nat Big LEO MSS licensees desiring ATC authorization will be able to coordinate with BAS licensees to avoid causing harmful interference to BAS Channel A10. Therefore, we note that BAS licensees using BAS Channel A10 are "grandfathered," and are entitled to operate without interference from MSS/ATC operations. Big LEO band MSS operators seeking to add ATC to their systems will be required to coordinate their use of the 2483.5-2500 MHz band with BAS licensees, or may negotiate with those licensees for relocation or some other solution to potential interference problems. To that extent, we grant SBE's request. We will not, however, mandate a relocation scheme for BAS Channels A8, A9, and A10, despite Globalstar's w ngness to consider relocation of BAS licensees under certain, limited conditions.[223]

## V. CONCLUSION

95. The actions we take in this *Memorandum Opinion and Order and Second Order on Reconsideration* will itate the development of MSS/ATC. By replacing certain uplink interference rules with a standard c erference, we allow MSS/ATC operators the freedom to design their systems to meet their customers' needs while protecting other MSS systems from harmful interference. By revising base station power limits in the L-band downlink, we allow MSS/ATC operators to build more powerful base stations while ensuring that they do not exceed the measured tolerance of MSS METs for interfering signals. Finally, by modifying the licensing rules, we provide equal opportunity for operational and non-operational MSS systems to add ATC without undue delay. These actions will advance the Commission's goal of ensuring efficient and intensive use of the spectrum, and will bring more options for high-quality communications at reasonable cost to all Americans.

## VI. PROCEDURAL MATTERS

96. *Final Regulatory Flexibility Certification* The Regulatory Flexibility Act of 1980, as amended (RFA),[224] requires that a regulatory flexibility analysis be pared for notice-and comment rule making proceedings, unless the agency certifies that "the rule will , if promulgated, have a significant economic impact on a ubstantial number of small entities."[225] The RFA generally defines the term "small entity" as having the same meaning as the terms "small business," "small organization," and "small governmental jurisdiction."[226] In addition, the term "small business" has the same meanin as the term "small business concern" under the Small Business Act.[227] A "small business concern" is o which: (1) is independently owned and perated; (2) is not dominant in its field of operation; and (3) satisfies any additional criteria established by the Small Business Administration (SBA).[228]

[222] *See id.* at 2-3.

[223] *See* Globalsta *osition* at 3-5.

[224] The RFA, *se* .S.C § 601-612, has been amended by the Small Business Regulatory Enforcement Fairness Act of 1996 (SBREFA), pub. L. No. 104-121, Title II, 110 Stat. 857 (1996).

[225] 5 U.S.C 5(b).

[226] 5 U.S.C 6).

[227] 5 U.S.C 3) incorporating by reference the definition of "small-business concern" in the Small Business Act, 15 U. 2). Pursuant to 5 U.S.C. § 601(3), the statutory definition of a small business applies "unless an agency, af ultation with the Office of Advocacy of the Small Business Administration and after opportunity for public ent, establishes one or more definitions of such term which are appropriate to the activities of the agency and publishes such definition(s) in the Federal Register."

[228] 15 U.S.C. § 632.

97. As required by the RFA, an Initial Regulatory Flexibility Analysis (IRFA) was incorporated in the *Flexibility Notice,* and no parties responded to the IRFA.[229] After a review of the policies and rules adopted in the *Flexibility Order*, the Commission determined that there would be no significant impact on a substantial number of small entities. Thus, a Final Regulatory Flexibility Certification was included in the *Flexibility Order.*[230]

98. In addressing the issues raised by the parties seeking reconsideration of the *Flexibility Order,* no parties commented on the regulatory flexibility certification. For the reasons described below, we certify that the policies and rules adopted in the *Memorandum Opinion and Order and Second Order on Reconsideration* will not have a significant impact on a substantial number of small entities.

99. We are incorporating the Final Regulatory Analysis Certification contained in the *Flexibility Order* into this proceeding. In our reconsideration of the petitions in this proceeding, we modify our rules to permit the addition of ATC to MSS systems. We change certain technical standards for ATC in the L-band, in order to permit MSS/ATC licenses flexibility in designing and operating their ATC while at the same time preventing harmful interference from ATC to co-primary MSS licensees in the L-band. In addition, we will allow certain increases in ATC base station power. We also modify the rules for authorizing MSS operators to add ATC to their networks. We expect that these changes will facilitate the development of MSS/ATC. We believe that all entities, both large and small, will have the flexibility to design their systems to meet their customers' needs. The policies and rules adopted in this proceeding are essentially technical changes that will provide equal opportunity for operational and non-operational MSS systems to add ATC without undue delay.

100. We believe that the policies and rules adopted in this proceeding – which brings additional flexibility to existing MSS licensees -- will not affect a substantial number of small entities. There are currently five 2 GHz MSS licensees, two Big LEO MSS licensees and three L-band MSS licensees authorized to provide service in the United States. Although at least one of the 2 GHz MSS system licensees and one of the Big LEO licensees are small businesses, small businesses often do not have the financial ability to become MSS system operators because of the high implementation costs associated with satellite systems and services. We expect that, by the time of MSS ATC system implementation, these current small businesses will no longer be considered small due to the capital requirements for launching and operating a proposed system.

101. Therefore, we certify that the requirements of the Memorandum *Opinion and Order and Second Order on Reconsideration* will not have a significant economic impact on a substantial number of small entities.

102. The Commission will send a copy of the *Memorandum Opinion and Order and Second Order on Reconsideration,* including a copy of this Final Regulatory Flexibility Certification, in a report to Congress pursuant to the Congressional Review Act.[231]

103. *Final Paperwork Reduction Act Analysis.* This item does not contain proposed

[229] *MSS Flexibility Notice*, 16 FCC Rcd 15,532 at 15,565-67, ¶¶ 85-93.

[230] *MSS Flexibility R&O*, 18 FCC Rcd 1962 at 2214-15, Appendix D, ¶ 2.

[231] *See* 5 U.S.C. § 801(a)(1)(A).

information collections subject to the Paperwork Reduction Act of 1995 (PRA), Public Law No. 104-13. It also, therefore, does not contain any new or modified "information collection burden for small business concerns with fewer than 25 employees," pursuant to the Small Business Paperwork Relief Act of 2002, Public Law No. 107-198, *see* 44 U.S.C. § 3506(c)(4).

## VII. ORDERING CLAUSES

104. IT IS ORDERED that, pursuant to sections 4(i), 7, 302, 303(c), 303(e), 303(f) and 303(r) of the Communications Act of 1934, as amended, 47 U.S.C. sections 154(i), 157, 302, 303(c), 303(e), 303(f) and 303(r), this Memorandum Opinion and Order and Second Order on Reconsideration IS ADOPTED and that Part 25 of the Commission's Rules IS AMENDED, as specified in Appendix B, effective 30 days after publication in the Federal Register.

105. IT IS FURTHER ORDERED that the etition for Reconsideration filed by Cingular Wireless LLC IS GRANTED in part to the extent described above and IS DENIED in all other respects.

106. IT IS FURTHER ORDERED that the Petition for Reconsideration filed by the Society of Broadcast Engineers, Inc. IS GRANTED in part to the extent described above and IS DENIED in all other respects.

107. IT IS FURTHER ORDERED that the Petition for Reconsideration filed by Mobile Satellite Venture ibsidiary LLC IS GRANTED in part to the extent described above, IS DISMISSED as moot in part t e extent described above, and IS DENIED in all other respects.

108. IT IS FURTHER ERED that the Petition for Reconsideration filed by Inmarsat Ventures PLC IS GRANTED in p he extent described above, IS DISMISSED as moot in part extent described above, and IS DENIED in all other respects.

109. IT IS FURTHER ORDERED that the Petition for Reconsideration filed by the Cellular Telecommunications & Internet Association IS GRANTED in part to the extent described above and IS DENIED in all other respects.

110. IT IS FURTHER ORDERED that the Petition f Reconsideration of the MSS Flexibility R&O filed by the Boeing Co. IS GRANTED in part to the extent described above and IS DENIED in all other respects.

111. IT IS FURTHER ORDERED that the Petition for Reconsideration of the Sua Sponte Order filed by the Boeing Co. IS GRANTED in part to the extent described above and IS DENIED in all other respects.

112. IT IS FURTHER ORDERED that the Final Regulatory Flexibility Certification, as required by section 604 of the Regulatory Flexibility Act, IS ADOPTED.

113. IT IS FURTHER ORDERED that the Commission's Consumer Information Bureau, Reference Information Center, SHALL SEND a copy of this Memorandum Opinion and Order and Second Order on Reconsideration, including the Final Regulatory Flexibility Certification, to the Chief Counsel for Advocacy of the Small Business Administration.

FEDERAL COMMUNICATIONS COMMISSION

Marlene H. Dortch
Secretary

## APPENDIX A

## Test Report

## Inmarsat Terminal Interference Susceptibility Testing

### 1. INTRODUCTION

1.1. In the *MSS Flexibilty R&O*, we assumed a saturation level of -50 dBm for Inmarsat airborne terminals and -60 dBm for mass-produced terrestrial receivers, and used these levels to calculate protection criteria for Inmarsat mobile earth terminal (MET) receivers from signals from ATC base stations in the 1525-1559 MHz band.[232] We subsequently received filings in petitions for reconsideration from MSV and from Inmarsat regarding signal power levels that would cause harmful interference to Inmarsat METs receivers by signals from MSV's ATC base stations. MSV stated, based on tests it had performed, that the signal power level required to cause harmful interference through the mechanism of receiver overload[233] is -45 dBm at the input to the receiver low-noise amplifier.[234] In support of its argument, MSV presented data on the 1 dB compression point[235] of the front ends[236] of several Inmarsat MET receivers.[237] Inmarsat stated that MSV's 1 dB compression point technique is not a proper way to determine the harmful interference threshold of Inmarsat MET receivers.[238] Inmarsat also stated that the correct value for the harmful interference threshold in its MET receivers is -75 dBm.[239] Furthermore, Inmarsat claimed that Inmarsat MET receivers could be susceptible to intermodulation product interference[240] at signal levels much lower than those required to produce receiver overload.[241]

---

[232] *See MSS Flexibility R&O* at Appendix C2, ¶ 1.12.

[233] Receiver overload occurs when a signal at the input of a receiver's amplifier reaches an amplitude sufficient to cause the amplifier to attempt to exceed its maximum possible output level, consequently distorting the output signal waveform. If a strong signal from a nearby ATC base station overloads the amplifier in an Inmarsat terminal receiver, the amplifier will distort the waveforms of both the ATC signal and a concurrently-received Inmarsat satellite signal. The amplifier's distortion of the satellite-signal waveform will cause demodulation errors and resultant errors in the receiver's output.

[234] MSV *Petition* at 16-17.

[235] When an amplifier is operated in its linear range, the gain of the amplifier is constant as the input signal level is varied, i.e. the output signal level is always G dB higher than the input signal level, where G is the gain of the amplifier in dB. As the input signal level is increased beyond the linear range of the amplifier, the 1 dB compression point of the amplifier is the input signal power level at which the gain of the amplifier becomes G-1 dB.

[236] The "front end" of a receiver typically comprises the first RF amplifier and some frequency-selective components that together establish the noise figure and RF bandwidth of the receiver.

[237] MSV *Petition* at Appendix C.

[238] Inmarsat *Opposition* at A-8.

[239] *Id.* at 16.

[240] Intermodulation products occur when two or more signals at different frequencies combine in a receiver or other device to create signals at frequencies that are the sums and differences of integer multiples of the original signals. Intermodulation product frequencies are calculated by: $f_{IM}=n*f_1 \pm m*f_2$, where $f_{IM}$ is the frequency of the intermodulation product, $f_1$ and $f_2$ are the interfering signal frequencies, and n and m are integers greater than zero. If an intermodulation product is created by two MSV ATC base station signals on a frequency being used by an Inmarsat receiver, harmful interference to the Inmarsat receiver may occur, depending on the levels of the ATC base station signals at the input to the Inmarsat receiver. The strongest intermodulation products occur when m + n = 3, i.e. when m = 1 and n = 2, or m = 2 and n = 1. These are known as "third-order" intermodulation products.

1.2. In order to understand and resolve the 30 dB difference (-45 dBm versus -75 dBm) between the harmful interference threshold values proposed by MSV and Inmarsat, we decided to conduct independent tests on Inmarsat METs. The International Bureau asked Inmarsat to supply METs and the special test equipment required to simulate the link from the METs through its satellites to its land earth stations. The Bureau asked MSV to supply the METs on which it had conducted receiver front-end 1 dB compression point measurements.

1.3. Inmarsat arranged to have its equipment manufacturers supply four METs for testing. One of these METs is an Inmarsat Fleet 77 marine terminal, one is designed for vehicular mounting and is based on a similar Inmarsat Fleet 55 marine terminal, and two are portable METs. These METs are all capable of receiving 64 kilobit per second (kbps) 16-state quadrature-amplitude modulation (16QAM), as is used in Inmarsat's Global Area Network (GAN). All have a 64 kbps Integrated Services Digital Network (ISDN) interface, which were used to conduct bit-error-rate (BER) tests on the METs.

1.4. Inmarsat's equipment manufacturers did not provide an airborne MET. Inmarsat held some informal discussions with Bureau staff regarding visiting an airborne MET manufacturer to conduct tests on an airborne Inmarsat MET, stating that the specialized test equipment required to test an airborne MET should not be moved from the manufacturer's facility. However, these discussions did not progress to an on-site test, so no airborne METs were tested.

1.5. We also held informal discussions with Inmarsat regarding testing Inmarsat's higher data rate B-GAN terminals. Inmarsat informed our staff that the B-GAN terminal was in the prototype stage and that the prototype terminal would not be ready for interference testing until sometime in October, 2004, several weeks after we had planned to complete the testing. In addition, Inmarsat told our staff that it would be necessary to conduct the tests at the facility of Inmarsat's manufacturing partner, Hughes Network Systems, in San Diego, CA. We were of the opinion that testing a prototype terminal in a facility not under the Commission's control could result in questionable test data. Inmarsat has recently disclosed that the B-GAN terminal is still in the prototype stage, i.e., it is not yet a commercially-available production item like the other terminals we tested for susceptibility to interference from simulated ATC base station signals.

1.6. We did not test the METs supplied by MSV due to lack of proper test equipment and test software for these particular METs.[242]

## 2. METHODOLOGY

2.1. We conducted the tests on the METs supplied by Inmarsat's equipment manufacturers in accordance with the test plan shown in Annex 1 of this report. We used specialized test equipment supplied by Inmarsat to generate the simulated Inmarsat satellite signals and to conduct bit-error-rate (BER) tests on the METs. Synthesized signal generators with built-in arbitrary waveform generators generated simulated interfering signals. We tested the receivers with three different types of signals: an unmodulated sine wave (CW) signal, a simulation of a variant of the Global System for Mobile communications (GSM) forward-link signal proposed by MSV ("MSV's GSM"), and a simulated cdma2000®[243] signal. The CW

(...continued from previous page)
[241] Inmarsat *Opposition* at A-8.

[242] A question of handling was also raised about these METs.

[243] cdma2000® is a registered trademark of the Telecommunications Industry Association (TIA-USA) in the United States.

signal would not be transmitted by an ATC base station (except perhaps for testing the base station transmitter), but it was included for reference purposes. The simulated interfering signals were combined with the simulated Inmarsat satellite signals using a two-way radiofrequency (RF) power combiner.

2.2. We used a spectrum analyzer to measure the cable and other losses from the signal generators to a convenient signal monitoring point in the test setup, and the cable losses to the point of connection to the Inmarsat METs receivers. These loss measurements used the signal generators to generate a CW signal in 250 kHz steps across the 1525-1559 MHz band, and used the spectrum analyzer to record the signal level every 250 kHz. We recorded the spectrum analyzer measurements on a floppy disk and imported into a spreadsheet. We then used the spectrum analyzer to measure the interfering signal levels at the monitoring point, and recorded the measured values using the spreadsheet. We used the spreadsheet to calculate the level of the interfering signals at the input to the Inmarsat MET receivers.

2.3. For all tests, we maintained the simulated Inmarsat signal at 1530 MHz at a $C/N_0$ level 2 dB higher than that required to achieve a BER of approximately $1 \times 10^{-5}$ when the simulated ATC base station signal was turned off. For the single-carrier harmful interference susceptibility tests, we varied the frequency of the simulated interfering signal frequency over the 1525 to 1559 MHz band. For the third-order intermodulation product harmful interference susceptibility tests, we used the pairs of frequencies shown in the tables in section 5 of the test plan. We maintained the two signals generating the third-order intermodulation products within 1 dB of the same power level at the input to the Inmarsat MET receiver. We recorded the simulated interfering signal power levels required to achieve a BER of approximately $1 \times 10^{-4}$.

## 3. SUMMARY OF RESULTS

3.1. In presenting the results of the testing, we will not identify the four Inmarsat METs staff tested by manufacturer and model number, because this information is not essential for understanding the test results. Instead, we will identify the METs as "Inmarsat Terminal A, Inmarsat Terminal B, Inmarsat Terminal C, and Inmarsat Terminal D". Inmarsat Terminal B is what Inmarsat calls a "Fleet 77" MET, and Inmarsat Terminal D is the land-mobile MET derived from what Inmarsat calls a "Fleet 55" MET. Inmarsat Terminals A and C are portable MET.

3.2. Our staff found that three of the four Inmarsat MET receivers tested were more resistant to harmful interference from single simulated ATC base station forward-link signals than MSV's proposed -45 dBm overload threshold, if the interfering signal was offset in frequency by at least 5 MHz from the desired Inmarsat signal. These three METs exhibited harmful interference thresholds above -40 dBm when the interfering signals were sufficiently offset in frequency from the desired Inmarsat signal. One MET had a harmful interference threshold of approximately -52 dBm. Figure 1 shows the power levels of the simulated ATC base station signals that resulted in harmful interference to the Inmarsat MET receivers. Note that some datapoints are missing because the level of the simulated interfering signal required to cause harmful interference to the Inmarsat MET receiver exceeded the limitations of the test equipment. The ordinate of each plot is labeled with the level of the interfering signal that caused a BER of approximately $1 \times 10^{-4}$ when the simulated Inmarsat satellite signal was maintained at a $C/N_0$ level 2 dB higher than that required to produce a BER of $1 \times 10^{-5}$ when no interference was present. The abscissa of each plot is labeled with the frequency of the interfering signal; the simulated Inmarsat satellite signal was maintained at 1530 MHz.

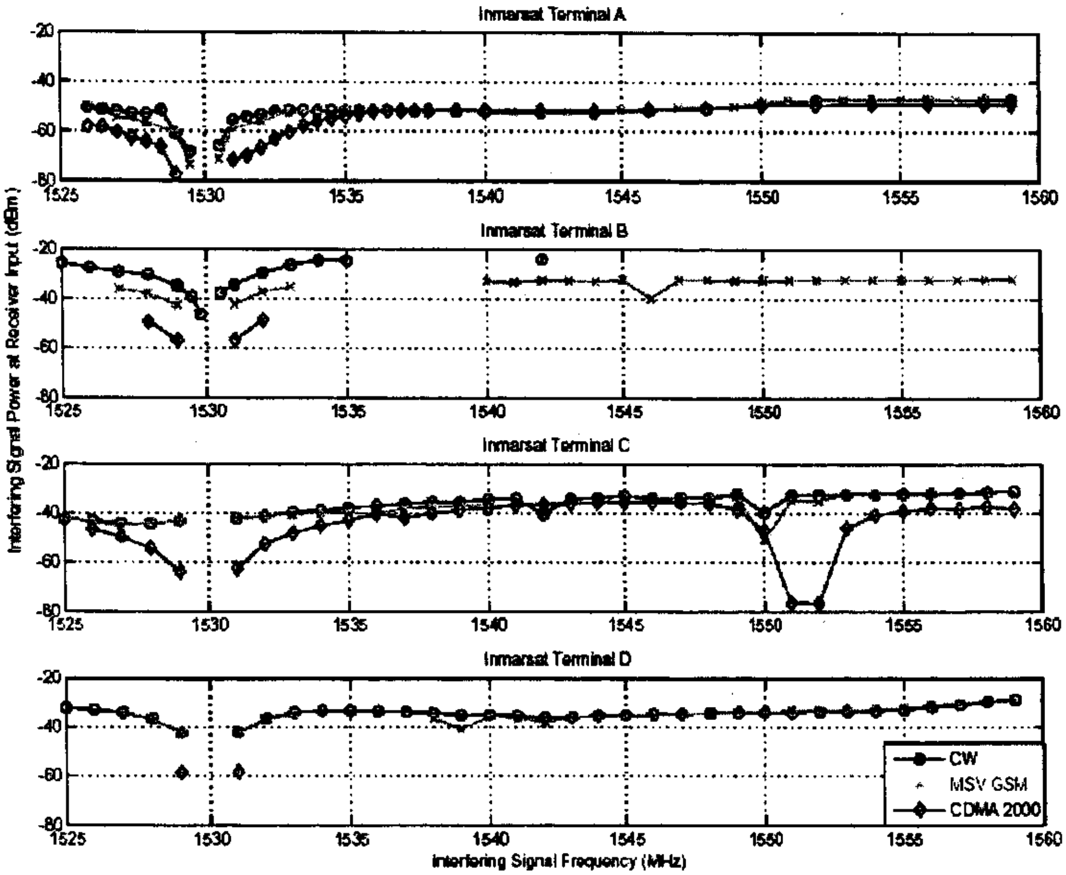


Figure 1: Inmarsat Terminal Single-Carrier Harmful Interference Levels.

3.3. The results show that in general, the simulated cdma2000 waveform resulted in harmful interference at lower root-mean-square (rms) power levels than MSV's GSM signal or the CW signal. This might be due to the higher peak-to-average power ratio[244] of the cdma2000 waveform as compared to the offset quadrature-phase-shift keyed (OQPSK) waveform used in MSV's GSM and as compared to the CW signal, which is a constant-envelope signal.[245]

3.4. Our staff found all four of the Inmarsat MET receivers to be susceptible to harmful interference from third-order intermodulation products of pairs of simulated ATC base station signals at much lower interfering signal levels than the levels required for harmful interference from a single simulated ATC base station signal. For the simulated MSV's GSM signals, the levels that caused harmful interference due to third-order intermodulation products ranged from approximately -50 dBm for the receiver most resistant to interference from third-order intermodulation products to approximately -75 dBm for the receiver least resistant to interference from third-order intermodulation products, when both of the two signals generating the intermodulation product were offset from the simulated Inmarsat satellite signal at 1530 MHz by 1 MHz or more. Note that these levels are the combined power of two signals contributing to the third-order intermodulation product -- each signal is 3 dB lower than the combined power level.

[244] Peak-to-average power ratio is the ratio of the instantaneous peak power of a signal to its time-averaged power. A CW signal has a peak-to-average power ratio of 1:1, or 0 dB. A standard GSM signal using Gaussian minimum-shift keying (GMSK) also has a peak-to-average power ratio of 0 dB. MSV's GSM signal has a peak-to-average power ratio of about 3.8 dB, and a nine-channel cdma2000 signal has a peak-to-average power

[245] A constant-envelope signal is one in which the RF envelope of the signal has constant amplitude, and the peak-to-average power ratio is 0 dB.

3.5. Figure 2 shows the combined power levels of two interfering signals contributing to the third-order intermodulation product that resulted in harmful interference to the Inmarsat MET receivers. The ordinate of Figure 2 is labeled with the combined power level of the pair of interfering signals that creates a third-order intermodulation product at 1530 MHz. The abscissa of Figure 2 is labeled with the frequency of f2, where the intermodulation product is at 1530 MHz = 2f1-f2.

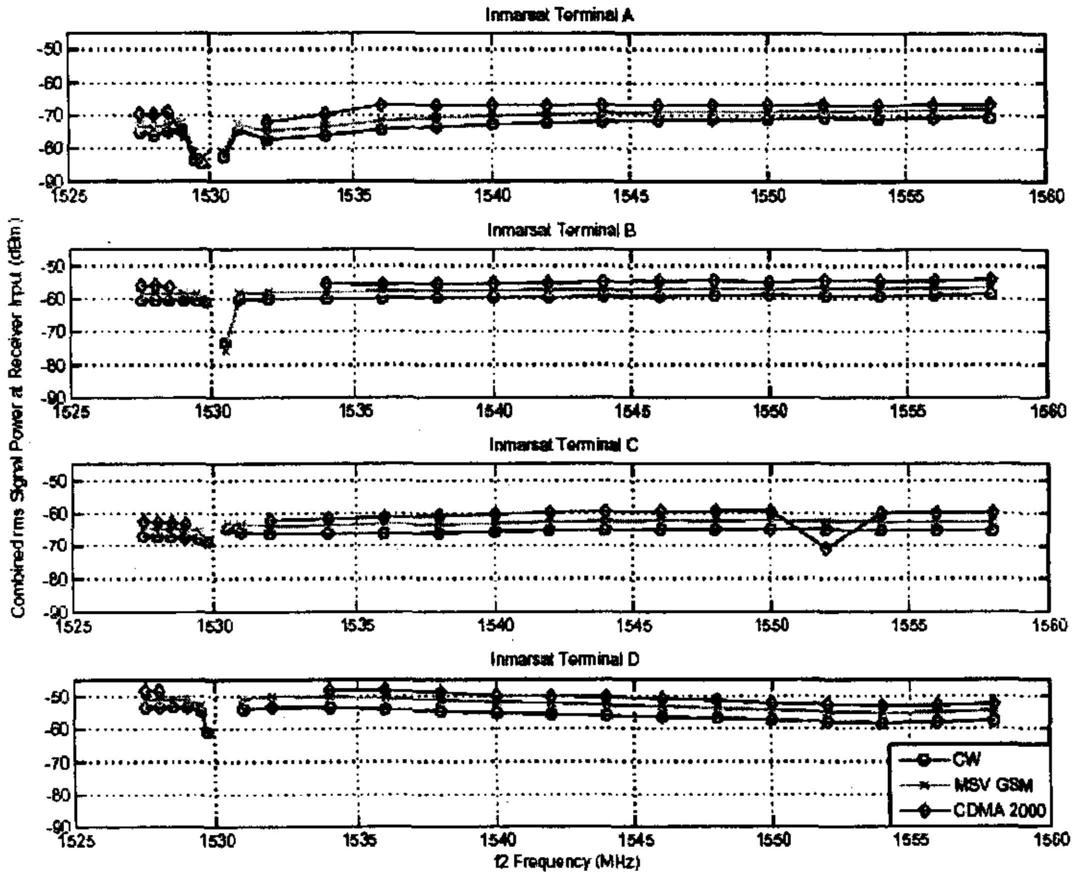


Figure 2: Inmarsat Terminal Third-Order Intermodulation Product Harmful Interference Levels.

3.6. The results show that in general, a pair of CW signals produces harmful interference due to third-order intermodulation products at a lower level than a pair of simulated MSV's GSM signals. A pair of simulated MSV's GSM signals produces harmful interference due to third-order intermodulation products at a lower level than a pair of simulated cdma2000 signals. The difference in level might be due to the fact that the simulated Inmarsat satellite signal that is being interfered with has a bandwidth of approximately 40 kHz, while a pair of CW signals produce an intermodulation product that is (at least theoretically) 0 Hz wide, a pair of simulated MSV's GSM signals produce an intermodulation product that is approximately 600 kHz wide, and a pair of cdma2000 signals produce an intermodulation product that is approximately 3.75 MHz wide. Therefore, all the energy of the intermodulation product produced by the pair of CW signals falls within the bandwidth of the simulated Inmarsat satellite signal. But the intermodulation product produced by a pair of simulated MSV's GSM signals is spread over a bandwidth approximately 15 times (11.8 dBHz) as wide as the simulated Inmarsat satellite signal, and the intermodulation product produced by a pair of simulated cdma2000 signals is spread over a bandwidth approximately 93.75 times (19.7 dBHz) as wide as the simulated Inmarsat satellite signal.

3.7. One might therefore expect MSV's GSM signal to need to be 11.8 dB stronger and the cdma2000 signal to need to be 19.7 dB stronger than a CW signal to produce the same harmful interference as the CW signal, since the third-order intermodulation product is spread over a wider bandwidth than the simulated Inmarsat satellite signal, but this is not the case. The difference is on the order of 2 to 3 dB between the CW signal and MSV's GSM signal, and the same amount between MSV's signal and the cdma2000 signal. One reason this might happen is that the higher peak-to-average ratios of MSV's GSM signal compared to the CW signal, and the cdma2000 signal compared to both MSV's GSM signal and the CW signal, may result in higher levels of interference from cdma2000 and MSV's GSM signals than that which results from a constant-envelope signal. The signal peak power levels are significantly higher than their rms powers for MSV's GSM and cdma2000. The Inmarsat satellite receiver amplifiers may experience overloading on the signal peaks. Another possible explanation is that the bandpass filters in the Inmarsat MET receivers allow some energy to come in from the frequency bands adjacent to the simulated Inmarsat satellite signal.

3.8. Figure 3 below shows the composite single-carrier harmful interference levels (top figure) and the composite third-order intermodulation product harmful interference levels for all four Inmarsat METs and for MSV's GSM and cdma2000 modulation. Solid lines in both figures show the harmful interference signal levels for MSV's GSM; dot-dashed lines show the harmful interference signal levels for cdma2000.

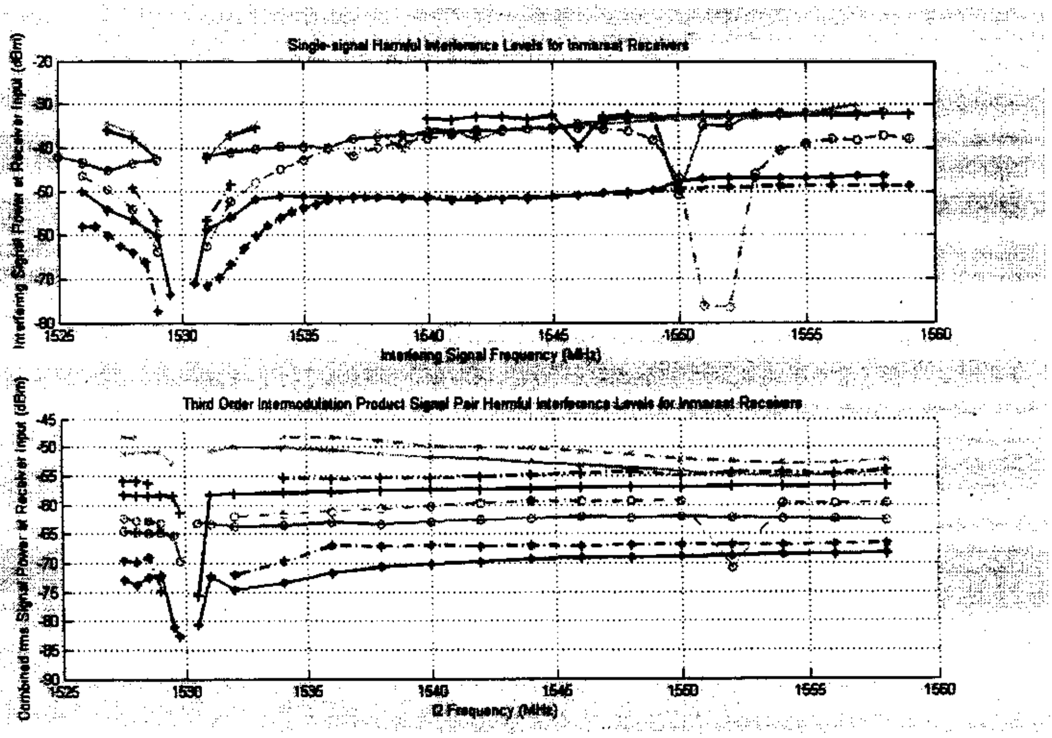


Figure 3: Single-signal and Third-Order Intermodulation Signal Pair Harmful Interference Levels for MSV's GSM and cdma2000 Modulation for Four Inmarsat Terminal Receivers

## RESULTS FOR EACH MET

3.9. The ordinate of each even-numbered figure below is labeled with the level of the interfering signal that caused a BER of approximately $1x10^{-4}$ when the simulated Inmarsat satellite signal was maintained at a $C/N_0$ level 2 dB higher than that required to produce a BER of $1x10^{-5}$ when no interference was present. The abscissa of these figures is labeled with the frequency of the interfering signal; the simulated Inmarsat satellite signal was maintained at 1530 MHz.

3.10. The ordinate of the odd-numbered figures below is labeled with the combined power level of the pair of interfering signals that creates a third-order intermodulation product at 1530 MHz. The abscissa of these figures is labeled with the frequency of f2, where the intermodulation product is at 1530 MHz = 2f1-f2.

3.11. Inmarsat Terminal A

3.11.1. Inmarsat Terminal A is a portable Inmarsat MET. The single-carrier harmful interference susceptibility levels for this MET are shown in Figure 3. The third-order intermodulation product harmful interference susceptibility levels for this MET are shown in Figure 4.

3.11.2. Referring to Figure 4 below, one can see that the level of the CW signal that causes harmful interference to the Inmarsat Terminal A receiver is about -50 dBm at 1526 MHz, falling to about -68 dBm at 1529.5 MHz. It rises from about -66 dBm at 1530.5 MHz to about -52 dBm at 1533 MHz. The level stays in the range of about -51 to -52 dBm from 1533 MHz to about 1546 MHz, then rises to about -47 dBm at 1552 MHz and remains at this level until 1559 MHz. The simulated MSV's GSM interfering signal level closely tracks the CW signal level, except that it is somewhat lower at small frequency offsets relative to the 1530 MHz simulated Inmarsat satellite signal. The simulated cdma2000 interfering signal level is about -58 dBm at 1526 MHz, falling to about -78 dBm at 1529 MHz. It rises from about -72 dBm at 1531 MHz to about -52 dBm at 1536 MHz, and remains at this level until about 1546 MHz. It rises to about -49 dBm at about 1552 MHz, and remains at this level until 1559 MHz.

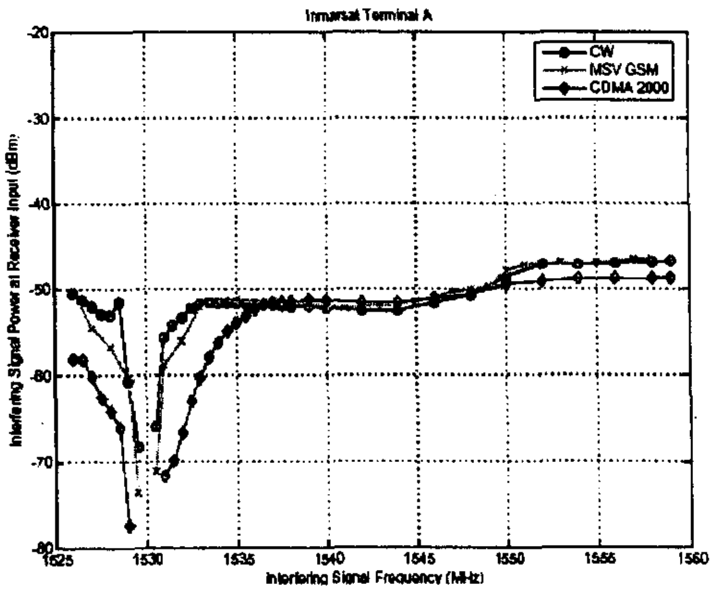


Figure 4: Inmarsat Terminal A Single-Carrier Harmful Interference Levels.

3.11.3. Referring to Figure 5 below, one can see that the combined power level of a pair of CW signals that causes harmful interference due to third-order intermodulation products in the receiver of Inmarsat Terminal A ranges from a low of about -85 dBm to a high of about -70 dBm. The level of the interfering pair of simulated MSV's GSM signals is typically about 2 to 3 dB higher than that of the CW signal pair. The level of the interfering pair of simulated cdma2000 signals is typically about 2 to 3 dB higher than that of the MSV's GSM signal pair.

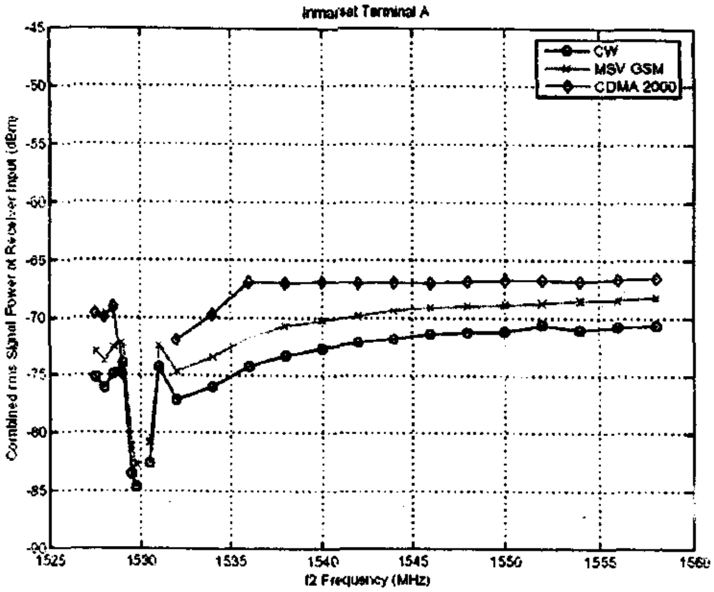


Figure 5: Inmarsat Terminal A Third-Order Intermodulation Product Harmful Interference Levels.

3.12. Inmarsat Terminal B

3.12.1. Inmarsat Terminal B is an Inmarsat Fleet 77 marine terminal. The single-carrier harmful interference susceptibility levels for this MET are shown in Figure 6. The third-order intermodulation product harmful interference susceptibility levels for this MET are shown in Figure 7.

3.12.2. Figure 6 is missing many data points because it was not possible to measure them due to limitations in the test equipment, primarily in the signal generator, because of the high power level of the interfering signal required to cause harmful interference to this terminal's receiver. The interfering level of the CW signal was measurable from 1525 to 1529.5 MHz and from 1530.5 MHz through 1535 MHz, and at 1542 MHz. The simulated MSV's GSM interfering signal level was measurable at 1527, 1528, 1529, 1, 1532, and 1533 MHz, and from 1540 MHz through 1559 MHz. The simulated cdma2000 interfe level was only measurable at 1528, 1529, 1531, and 1532 MHz. Elsewhere, the signal genera noise at the levels required to measure the interfering signal level was too high to permit accurate measurements

3.12.3. In Figure 6 below, one can see that the level of the CW signal that causes harmful interference to the Inmarsat Terminal B receiver is about -38 dBm frequency offsets of ± 500 kHz from the simulated Inmarsat satellite signal at 1530 MHz. This level rises to about -26 dBm at 1525 MHz and 1533 MHz. Beyond 1535 MHz, the only data point that could be measured (due to equipment limitations) was about -24 dBm at 1542 MHz. The simulated MSV's GSM interfering level fell from about -36 dBm at 1526 MHz to about -43 dBm at 1529 MHz, and rose from about -42 dBm at 1531 MHz to about -35 dBm at 1533 MHz. From 1540 MHz through 1559 MHz, except at 1546 MHz, the level required for the simulated MSV's GSM signal to interfere with the simulated Inmarsat satellite signal was about -32 to -33 dBm. The dip to -40 dBm at 1546 MHz is unexplained, but was repeatable. The simulated cdma2000 interfering s al level is about -49 dBm at 1528 MHz, falling to about -58 dBm at 1529 MHz. It rises from about -56 dBm at 1531 MHz to about -48 dBm at 1532 MHz.

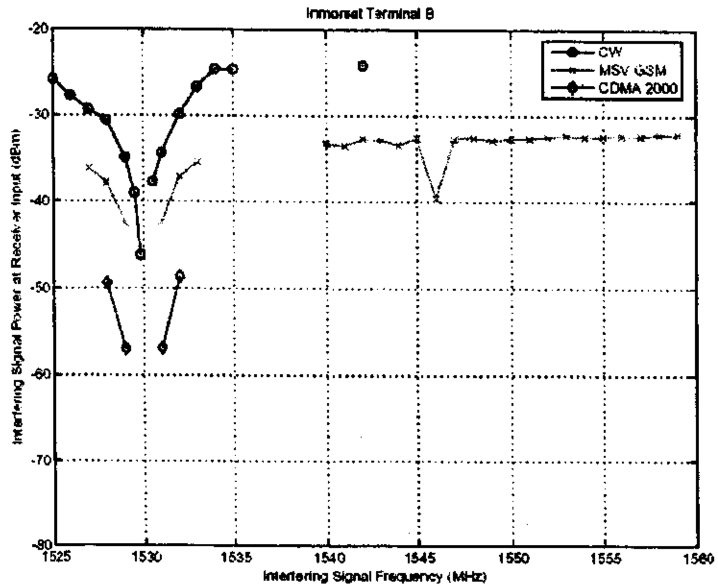


Figure 6: Inmarsat Terminal B Single-Carrier Harmful Interference Levels.

3.12.4. In Figure 7 below, one can see that the combined power level of a pair of CW signals that causes harmful interference due to third-order intermodulation products in the receiver of Inmarsat Terminal B ranges from a low of about -73 dBm to a high of about -58 dBm. The level of the interfering pair of simulated MSV's GSM signals is typically about 2 dB higher than that of the CW signal pair. The level of the interfering pair of simulated cdma2000 signals is typically about 2 dB higher than that of the MSV's GSM signal pair.

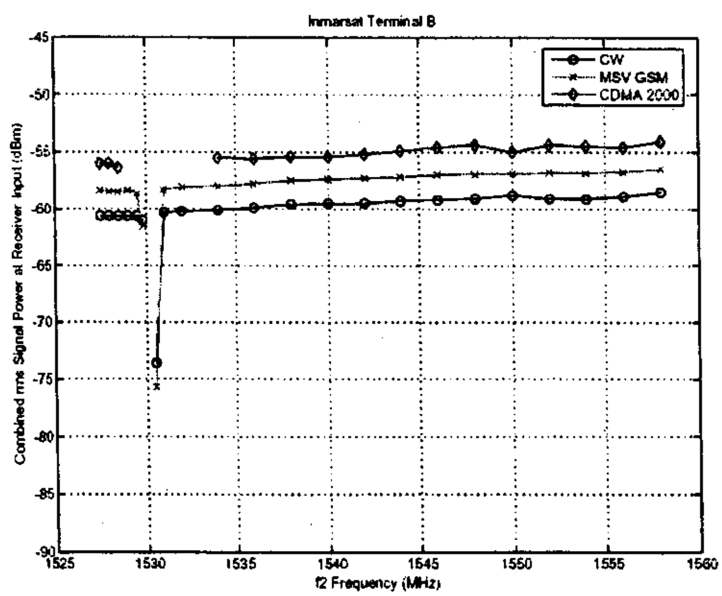


Figure 7: Inmarsat Terminal B Third-Order Intermodulation Product Harmful Interference

3.13. Inmarsat Terminal C

3.13.1. Inmarsat Terminal C is a portable Inmarsat MET. The single-carrier harmful interference susceptibility levels for this MET are shown in Figure 8. The third-order intermodulation product harmful interference susceptibility levels for this terminal are shown in Figure 9. This MET appears to be particularly susceptible to interfering signals offset by about 21.4 MHz. This might be due to the use of a superheterodyne receiver with an intermediate frequency (IF) in the vicinity of 10.7 MHz, and poor image rejection in the receiver.[246]

3.13.2. In Figure 8 below, one can see that the level of the CW signal that causes harmful interference to the Inmarsat Terminal C receiver is about -42 dBm at 1525 MHz. The CW interfering signal level remains in the range of -42 to -45 dBm until 1529 MHz. Beyond 1531 MHz, the CW interfering signal level gradually rises to about -35 dBm at 1529 MHz. There are two dips in the CW interfering signal level, one at 1542 MHz, and one at 1550 MHz. These dips are unexplained. The simulated MSV's GSM interfering level tracks the CW interfering signal level to within about 2 dB over most of the 1525-1559 MHz frequency range. The simulated cdma2000 interfering signal level is about -47 dBm at 1526 MHz, falling to about -63 dBm at 1529 MHz. It rises from about -62 dBm at 1531 MHz to about -35 dBm at 1545 MHz, which is the highest level it attains.

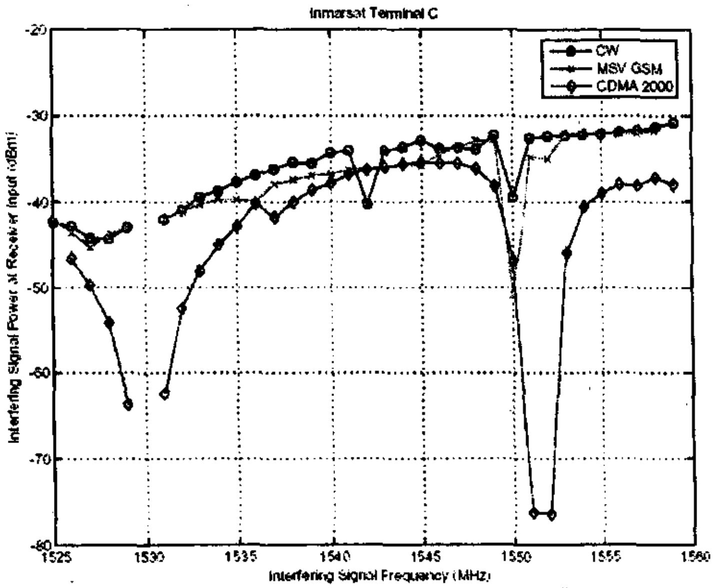


Figure 8: Inmarsat Terminal C Single-Carrier Harmful Interference Levels.

3.13.3. In Figure 9 below, one can see that the combined power level of a pair of CW signals that causes harmful interference due to third-order intermodulation products in the receiver of Inmarsat Terminal C ranges from a low of about -69 dBm to a high of about -65 dBm. The level of the interfering pair of simulated MSV's GSM signals is typically about 2 to 3 dB higher than that of the CW signal pair. The level of the interfering pair of simulated cdma2000 signals is typically about 2 to 3 dB higher than that of the MSV's GSM signal pair.

[246] In a superheterodyne receiver, the desired RF signal is converted to an intermediate frequency (IF) signal by mixing it with a signal from a local oscillator (LO). The mixing process converts signals at frequencies of both LO-RF and LO+RF to the same IF. For example, suppose the desired RF signal is centered at 1530 MHz. Suppose the LO is at 1540.7 MHz. Mixing the desired RF signal at 1530 MHz with the 1540.7 MHz LO will produce an IF signal at 10.7 MHz. However, if a signal is present at 1551.4 MHz, mixing this signal with the 1540.7 MHz LO will also produce an IF signal at 10.7 MHz.