NTIA REPORT 85-180

Spectrum Resource Assessment of Unlicensed Electronic Devices



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ABSTRACT

Increases in user demand for, and the availability of, new electronic products that don't require an individual operating license or frequency assignment have resulted in diverse use of the radio frequency spectrum in disparate operating environments. Some of these electronic devices have an impact on authorized Government telecommunications. The scope of identified problems, the recent revision of regulatory authority in this area, and the potential shown by recent technological advances requiring additional unlicensed spectrum demonstrate that relevant federal policy and its implementation require review.

This document, a spectrum resource assessment, addresses representative problems and policies regarding unlicensed electronic devices and presents approaches aimed at avoiding future problems associated with unlicensed devices.

Primary recommendations include; (1) the establishment of a centralized reporting system for interference related to unlicensed devices,(2) continued dialogue with the FCC and private industry, (3) review of future FCC actions related to unlicensed devices, and (4) the provision that NTIA, upon request, provide typical Government equipment characteristics to private industry.

KEY WORDS

Government Radio Services
Home Electronic Equipment and Systems
Incidental and Restricted Radiation Devices
Radio Frequency Devices
Radio Frequency Spectrum Management
Minimum Performance Standards
Unlicensed Receivers

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GLOSSARY OF TERMS

Act	Communications Act of 1934
AFB	Air Force Base
BSS	Broadcasting Satellite Service
DOE	Department of Energy
EIA	Electronic Industries Association
FCC	Federal Communications Commission
Hz	Hertz
IF	Intermediate frequency
IRAC	Interdepartment Radio Advisory Committee
ISM	Industrial, scientific, and medical
kHz	Kilohertz
m	Meter
MHz	Megahertz
NOI	Notice of Inquiry
NTIA	National Telecommunications and Information Administration
ODM	Office of Defense Mobilization
PABx	Private automatic branch exchange

PLC	Power-line carrier
RF	Radio frequency
RFI	Radio frequency interference
RSMS	Radio Spectrum Measurement System
V	Volts

SECTION 1

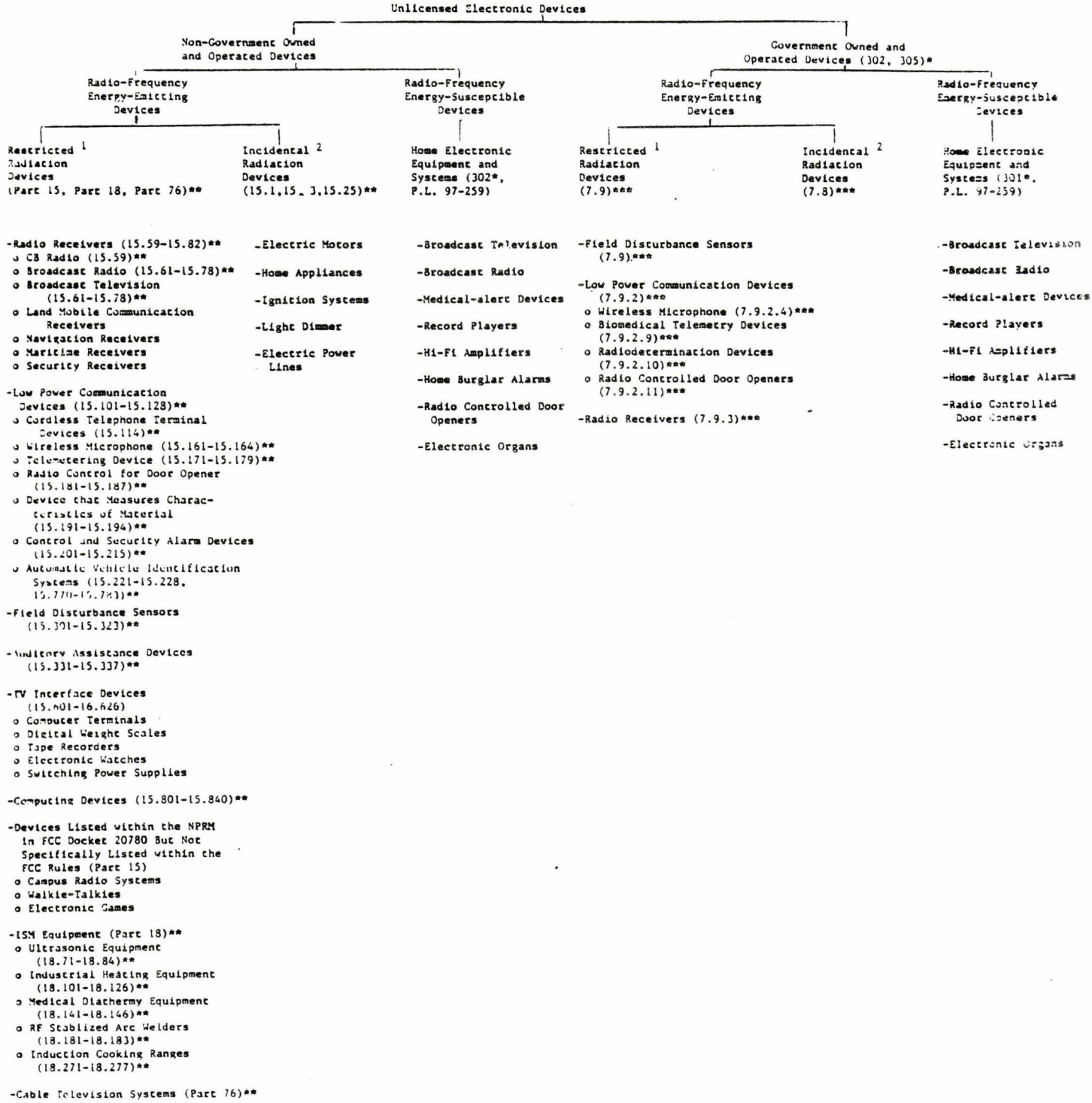
INTRODUCTION

BACKGROUND

The National Telecommunications and Information Administration (NTIA) is responsible for managing the US Federal Government's use of the spectrum. Part of NTIA's responsibility is to "...establish policies concerning spectrum assignment, allocation and use, and provide the various departments and agencies with guidance to ensure that their conduct of telecommunications activities is consistent with these policies" [NTIA, 1985]. In support of this, NTIA has undertaken a number of spectrum resource assessments and analyses. The objectives of these are to assess spectrum utilization, identify existing/or potential compatibility problems between systems of various departments and agencies, provide recommendations for resolving any compatibility conflicts, and recommend changes for more efficient and effective use of the spectrum and improved spectrum management procedures.

Recently, agencies within the Government have experienced interference between their authorized Government stations and electronic devices that do not require an individual operating license or frequency assignment. (Figure 1-1 lists these electronic devices and their associated directive references.) The interference is not always easy to resolve, resulting in degraded operation of either the unlicensed device or the authorized station.

Since Government agencies must retain flexible and interference-free access to the spectrum to fulfill their mandated missions and the use of the unlicensed electronic devices is continuing to proliferate, NTIA directed that a study be completed to evaluate the impact on Government spectrum use and to recommend a course of action for managing the problem.



1. A restricted radiation device is a device in which the generation of RF energy is intentionally incorporated into the design and in which the RF energy is conducted along wire or is radiated exclusive of transmitters which require licensing.

2. An incidental radiation device is a device that radiates RF energy during the course of its operation although the devices is not intentionally designed to generate RF energy. No specific examples are listed within the FCC Rules.

* Communications Act of 1934 (Section Number)
** Code of Federal Regulations 47CFR15
***NTIA Manual (Section Number)

Figure 1-1. Unlicensed electronic devices and their associated directives.

OBJECTIVES

The objectives of this study were to:

1. determine the nature and extent of the interference problems between Government stations and unlicensed electronic devices

2. evaluate existing spectrum management policy pertaining to the use of unlicensed electronic devices

3. examine alternatives for improved spectrum management of unlicensed electronic devices.

APPROACH

This study was conducted in three parts.

1. Members of the Interdepartment Radio Advisory Committee (IRAC) were requested to compile case-history information on interference problems involving authorized Government stations and unlicensed electronic devices.

2. Relevant portions of the NTIA Manual of Regulations and Procedures for Federal Radio Frequency Management [NTIA, 1985] and the Federal Communications Commission Rules and Regulations [FCC, 1983] were reviewed to identify existing Federal policy on unlicensed electronic devices.

3. Approaches for dealing with the problem were developed and listed in order of least regulatory burden.

SECTION 2

CONCLUSIONS AND RECOMMENDATIONS

GENERAL

Sections 301 and 303 of the Communications Act of 1934 (ACT) [Congress, 1934], the National Table of Frequency Allocations, the authorization procedures for granting station licenses as defined in the FCC Rules and Regulations [FCC, 1983] and the authorization procedures for granting frequency assignments defined in the NTIA Manual [NTIA, 1985] address authorized spectrum uses. Similarly, Section 302 of the ACT, Part 15 of the FCC Rules, and Chapter 7 of the NTIA Manual address the conditions placed on spectrum uses that are not individually authorized by license or frequency assignment. In essence, the established conditions require unlicensed spectrum users to avoid causing harmful interference to authorized radio-service operations and to accept all interference from ambient radio frequency electromagnetic fields.

As the use of various unlicensed electronic products proliferates, the occurrence of interference problems is expected to increase. Past problems have resulted from both interference to, and from, authorized Government operations that, under existing policy, are recognized as having a protected status. At this time, the documented instances, submitted by IRAC agencies, of these occurrences are limited in number and have been resolved on a case-by-case basis. However, not all cases are resolved without cost or inconvenience to the Government. Continued increases in the use of these devices could have significant impact on future Government operations unless steps are taken to effectively manage their interaction.

Improved methods for problem identification and documentation are needed before changes are made in Government policy. This documentation, together with continued dialogue with the FCC and private industry, will clarify the direction that the Government must take to protect its flexible and interference-free access to designated portions of the radio frequency spectrum.

The following conclusions take into account documented interference problems, Government and non-Government policies, and the resources available to support problem resolution.

CONCLUSIONS

1. No procedure exists in the NTIA Manual for reporting instances of interference involving Government stations and unlicensed electronic devices. The NTIA Manual encourages users involved in an interference incident to resolve the problem themselves rather than reporting such an incident to NTIA.

2. The problems between Government operations and unlicensed-device operations appear to be few, as reported by the Government agencies, and, in most cases, are resolved using existing procedures.

3. Due to the dynamic nature of electronics technology, periodic review of the adequacy of technical standards is required. Many of these standards, set by the FCC, could have an impact on Government users.

4. The information listed in Chapter 7, "Authorized Frequency Usage," of the NTIA Manual pertaining to Government use of incidental and restricted radiation devices relates more to radiated power levels than frequency usage and, therefore, is more qualified as a standard rather than a usage guide.

5. FCC standards for unlicensed electronic devices need to be reviewed to determine whether they should be included in the NTIA Manual and applied to Government-owned devices. The Technical Subcommittee (TSC) of the IRAC has this as a proposed agenda item.

6. The proper application of the sufferance rules to receivers is not clear in Part 15 of the FCC Rules. Because the sufferance rules existed before the FCC was granted authority through Public Law 97-259 [Congress, 1982], to regulate receivers, the question exists whether receivers are covered by those rules or whether they require additional FCC action. If receivers are not covered, a policy void exists relative to the impact of authorized stations on receivers.

7. Knowledge of Government receiver and transmitter characteristics benefits producers of unlicensed devices, as does data on actual Government spectrum occupancy. This helps the manufacturers avoid equipment designs that use frequencies that conflict with Government usage.

8. Part 15 of the FCC Rules states that data on Government spectrum use is available as it impacts the users of control and security-alarm devices.

9. Measured emission characteristics of selected unlicensed electronic devices (e.g., coin-operated video games, cordless telephones, remote meter-reading equipment), when identified as causing interference to Government users, would help in finding solutions preventing future problems.

10. The sources of some interference from unlicensed electronic devices are difficult to identify without the use of spectrum-measurement equipment and, as a result, the problems may go unresolved. The NTIA Radio Spectrum Measurement System (RSMS) Van is capable of performing measurements to assist in interference resolution.

11. FCC sufferance rules cover most instances of Government authorized station/unlicensed device interaction and should, in most cases, assist in problem resolution satisfactory to Government users. However, the use of these devices is expected to grow and have an increasing impact on Government use.

12. Ongoing discussion between the Government, the FCC, and industry will help to reach an understanding concerning the issues involved with the interference problem.

13. The development and operation of low-power communications devices in Government bands could create numerous conflicts between Government and private users.

14. Development of voluntary industry standards would increase safeguards for the use of unlicensed electronic devices, without adding to the regulatory burden.

15. There is insufficient documentation of problems to support implementation of the approaches given in Section 5 of this report, except for Approaches 3, 4 and 5.

RECOMMENDATIONS

The following are NTIA staff recommendations that are based on the technical findings contained in this report. Any action to implement these recommendations will be via separate correspondence modifying established rules, regulations, and procedures. The recommendations are as follows.

1. The IRAC should establish a method for reporting interference to, or from, unlicensed devices.

   a. IRAC agencies should provide guidance to subordinate organizations for submitting interference reports dealing with unlicensed devices.

b. IRAC agencies should compile and NTIA should review records of interference annually to update policy concerning these devices.

2. NTIA should periodically evaluate restrictions and standards, or proposed restrictions and standards, on the emissions, or susceptibility of unlicensed devices.

3. NTIA should move the technical provisions regarding incidental and restricted radiation devices in Chapter 7 of the NTIA Manual to Chapter 5.

4. The TSC should establish a working group to evaluate the regulations within Part 15 of the FCC Rules and Regulations to determine whether they should be applied to Government-owned unlicensed electronic devices and, therefore, be added as standards in the NTIA Manual.

5. The FCC should clarify whether the sufferance rules, written prior to the passage of Public Law 97-259, which provides authority to deal with receivers, are restricted in their application to receivers.

6. NTIA should continue to compile unclassified summaries of the characteristics of Government equipment and develop environmental summaries based upon spectrum-occupancy measurements of Government operations, and provide them to private industry upon request.

7. The FCC should change other applicable sections of Part 15 of the FCC Rules and Regulations to indicate the availability of the Government summaries as stated in paragraph 15.204.

8. NTIA should use the RSMS Van to measure the emission characteristics of selected unlicensed electronic devices (e.g., coin-operated video games, cordless telephones, and remote meter-reading equipment).

9. The NTIA RSMS Van should be used to take measurements in the vicinity of Government stations experiencing interference that may be related to unlicensed devices.

10. Government agencies should request the FCC to enforce the provisions of Part 15 of its Rules and Regulations in instances where they are unable to resolve problems locally instead of modifying their operations.

11. NTIA should maintain a dialogue with the FCC and private industry through participation in associated committees, attendance at related seminars and conferences, and preparation of technical papers as described in Approach 4.

12. The FCC should guide, where possible, low-power communications-device development into non-Government and industrial, scientific, and medical (ISM) bands.

13. The FCC should encourage industry to develop voluntary standards governing the characteristics of unlicensed electronic devices.

14. The implementation of other approaches to dealing with this problem should begin only after the interference-reporting-system documentation demonstrates the need.

SECTION 3

RADIO FREQUENCY INTERFERENCE PROBLEMS

GENERAL

Advances in solid-state technology and radio science have resulted in the development of many new unlicensed electronic products that could, and do, affect authorized Government spectrum users. The nature and severity of the interference problems encountered vary greatly, depending, to a large extent, on the manner in which radio frequency energy is used and the intended function of the product. In some products, such as cordless telephones, garage-door openers, and wireless microphones, the emission of radio frequency energy is essential to the intended function. In other products, such as receivers with local oscillators, video games, and computers, the emission of such energy is an unintentional consequence of signal processing, switching, or timing circuit operation. In some products, such as television and radio receivers, low-power communications systems receivers, and security/field disturbance sensors, the generation of responses resulting from the presence of ambient radio frequency electromagnetic fields is again essential to the intended function. In other products, such as computing devices, public-address-system amplifiers, and electronic church organs, the generation of such responses is an unintentional consequence of the product's lack of sufficient immunity (susceptibility) to radio frequency interference that can result in significant annoyance and, in some cases, economic loss to the unlicensed spectrum user.

The difficulty in resolving interference problems in a manner satisfactory to Government users often depends upon the level of public interest in the particular device. This interest generally reflects the number of devices in the hands of consumers or the size of the investment made in the products by manufacturers.

NATURE OF THE INTERFERENCE PROBLEM

The emissions of these proliferating unlicensed devices are bound to impact Government spectrum users for several reasons. First, any device that makes use of electromagnetic energy will generate some radio frequency signal level. Although these levels may be extremely low, the cumulative signals will take the form of an ever-rising noise floor. Increases in noise levels could pose a long-term threat to all Government communications systems, requiring increasing investments in signal-discrimination techniques. Some unlicensed systems are low-power communications systems that transmit on known frequencies. All unlicensed devices, however, emit spurious signals that may fall at any frequency. The unpredictable nature of these signals makes spectrum management difficult. Because satisfactory problem resolution has often been affected by public response, it is crucial that potential interference be identified before significant distribution of products occurs. However, many devices that have already been distributed and that have not interfered with Government users may experience problems as new authorized stations are introduced into the environment.

Second, the susceptibility of unlicensed devices has also caused problems. Interference may result through a spurious response or the addition of a new Government transmitter into what was otherwise an interference-free environment. Because many of the unlicensed devices are not made to receive radio frequency signals or because an effort was made to keep costs low, little has been done to insure that they are not susceptible to interference.

REPORTING INTERFERENCE

As directed in Section 8.2.30 of the NTIA Manual, Government spectrum managers resolve interference problems on the local level when reasonable solutions can be accomplished expeditiously; however, these managers are not required to report any problems. Consequently, there is no centralized, or comprehensive, collection of case histories on interference problems involving authorized Government spectrum users and unlicensed spectrum users. The problems listed below are representative of those encountered by agencies. Although the problems exist, it is believed that there are additional problems

of the types indicated and of types that have not been documented. Clearly, more comprehensive information is needed to determine the scope of these problems and to determine the coupling mechanisms causing specific interference before informed decisions can be made regarding the implementation of some of the approaches, which are proposed in Section 5 of this report, to addressing existing and potential spectrum conflicts.

Any centralized reporting system implemented should involve each of the IRAC agencies. Contact should be maintained with FCC and private industry committees reviewing this problem. The reporting system should not generate extensive reports, but merely establish a point of contact for information on problems experienced. Clearly, not all problems of a given type need to be analyzed in equal depth; however, a count of the problems by type is needed to determine the priority and the resources to be assigned in the analysis of each problem. Information gathered within the reporting system should include the data listed on the worksheet in Figure 3-1 for each incident.

EXAMPLES OF HARMFUL INTERFERENCE TO GOVERNMENT RADIO SERVICES

1. Video Game

   In Sumas, WA, radio frequency emissions from a coin-operated video game caused inband interference to an authorized Government VHF circuit. The problem was resolved when the FCC Field Operations Bureau notified the owner that the operation of the device was in violation of the FCC Rules and Regulations and the owner removed the game.

2. Electronic Private Automatic Branch Exchange (PABX)

   In Las Vegas, NV, radio frequency emissions from the digital switching circuitry of an electronic PABX, which is used in the local telephone network, caused interference to an authorized Department of Energy (DOE) public health and safety radio net.This problem was resolved by changing the operating frequency of the Government net from 36.33 to 416.975 MHz. This may, however, be only a temporary solution because the frequencies contained in the interfering signal apparently are determined by the manner in which the PABX's operating software is executed. Future changes in the execution of this software, therefore, may generate signals that will again affect the Government net operations.

Organization: _____

Contact: _____

Location: _____

Description of Interference Interaction

Government Equipment: _____

Unlicensed Device: _____

Frequency Involved in Interference: _____

Approximate Distance Between Equipment: _____

Frequency of Occurrence (How often): _____

Impact on Operation of Victim: _____

General Statement of Interference: _____

_____

_____

_____

_____

_____

_____

Method of Resolution: _____

_____

_____

Cost of Resolution to the Government: _____

Figure 3-1. Worksheet for data required by an interference-reporting system.

3. Television/FM Antenna Preamplifiers and Receivers, Computing Devices, Intrusion Alarms

In Green Bank, WV, radio frequency emissions from the above electronic devices have caused instances of interference to authorized radio-astronomy operations. Positive identification of the offending device has frequently been achieved, but additional cases exist where specific devices could only be suspected. Television/FM antenna preamplifiers present a particularly troublesome problem because of their widespread use throughout the community and because of their strong tendency to oscillate at fundamental frequencies ranging from 73-450 MHz, with emitted power levels of 1-1000 milliwatts. The approaches used to reduce these problems have included the replacement, at Government expense, of specific television/FM antenna preamplifiers.

EXAMPLES OF HARMFUL INTERFERENCE FROM GOVERNMENT RADIO SERVICES

1. Garage-Door Openers

Certain garage-door openers designed to operate in the 225-400 MHz frequency band have been susceptible to interference from authorized Government fixed, mobile, and aeronautical radionavigation radio operations. In some cases, the preset operating frequencies of the garage-door openers were found to be identical to the assigned frequencies of Government stations operating in the vicinity. This cochannel operation has resulted in the unwanted opening of garage doors during the authorized use of Government transmitters. The three approaches taken to reduce this problem were: (1) revision of the FCC rules to allow an 8 dB increase in the power emitted by garage-door-opener transmitters, which permits the use of less sensitive receivers; (2) use of digital coding by the manufacturers, which permits more reliable discrimination between desired and undesired signals; and (3) the manufacturers' consideration of certain authorized Government radio uses in selecting operating frequencies, which avoid cochannel operations.

2. Broadcast Television Receivers

The following four types of problems have been found to affect broadcast television receiver's susceptibility to interference from Government fixed, mobile, and radiolocation radio operations.

Cochannel Interference - The frequency of the interfering signal lies within the allocated 6 MHz bandwidth of a given television channel. Performance is degraded in only one channel.

Adjacent-Channel Interference - The frequency of the interfering signal lies outside, although near, the allocated 6 MHz bandwidth of a given television channel, but the television receiver cannot

discriminate the desired signal from the undesired signal. Performance is degraded in only one channel.

In approximately 60 U.S. cities, Channel 7 could, under the FCC Rules and Regulations, be licensed to operate in the band from 174-180 MHz. Immediately adjacent to this band is the 173.4-174 MHz band that is allocated for primary use by the Government nonmilitary fixed and mobile services. Past problems, generally, have occurred in Channel 7's fringe reception areas where the television signal was weak relative to the interfering signal present from the Government transmitter operations. The approach used to control this problem is to inform Government frequency managers of the problem and thus avoid using the 173.4-174 MHz bands in localities where this interference problem is likely to arise.

A set of factors similar to the above also applies to television Channel 13 operating in the band 210-216 MHz. Immediately adjacent to this band is the 216-220 MHz band that is allocated for primary use by both Government and non-Government maritime mobile services. The non-Government maritime mobile service operation's involvement in this problem has been addressed in two ways, (1) through a footnote in the allocation tables (non-Government Footnote 121), this radio service may be operated only along the Mississippi River and the Gulf Intracoastal Waterway, and (2) through a recent FCC action, license applicants are required to prepare detailed engineering determinations regarding the interference likely to arise between the proposed systems and Channel 63 reception.

Intermediate-Frequency (IF) Band Interference - Here the interfering signal lies within the 6 MHz passband of the IF amplifiers that are used in the receiver to detect all audio and video signals. Performance is degraded on all channels.

In most standard-design television receivers, the input radio frequency signal is mixed with a local-oscillator signal to generate two bands of IF signals. One of these bands is centered on 41.25 MHz and carries the audio information and the second band is centered on 45.75 MHz and carries the video information. These signals are then processed with IF amplifiers having a passband from approximately 41-47 MHz. Both Government and non-Government fixed and mobile services have primary allocation in selected portions of this band, and all have caused IF interference problems. Approaches to resolve this problem have included, (1) the installation of filters and antenna traps on affected receivers, (2) the revocation, by the FCC, of licenses where non-Government stations were operating in this band, and (3) the judicious assignment of frequencies by Government frequency managers to minimize community complaints.

High-Power Case Penetration - Here the interfering signal is of such a magnitude that, regardless of its frequency, it penetrates whatever limited shielding is present and causes certain portions of the receiver's circuitry to malfunction. Performance degradation varies depending on the intended functions of the malfunctioning circuits.

3. High-Power Case Penetration

The Air Force's operation of the AN/FPT-5 (an ionospheric sounding radar) and the AN/FPS-66A (a SAGE search radar) have caused interference to television receivers and other electronic devices including AM/FM receivers, intercoms, stereo systems, and amplifier/speaker systems. The AN/FPT-5 operates in Boston, Massachusetts, in the band 403.75-446.25 MHz and the AN/FPS-66A operates at Patrick Air Force Base (AFB), Florida, in the band 1250-1350 MHz.

Analysis thus far appears to indicate that these are high-power case-penetration problems. Studies of potential shielding solutions are continuing at Government expense.

4. Computing Devices

In the vicinity of Fort Bliss, Texas, an increasing number of complaints are arising because of degraded performance in civilian microprocessors and computers. The degraded performance appears to be caused by interference from radar signals generated during the Army training operations at Fort Bliss.

Approaches to minimize this problem include, (1) blanking the radar transmissions, in sectors where affected devices are known to exist, when mission requirements permit (2) providing technical advice to the computing device operator regarding actions that can be taken toward achieving greater immunity to radar-signal interference; and (3) defining the threshold of a selected computing device's susceptibility to radar-signal interference, thus enabling the development of a permanent solution to this problem.

EXAMPLES OF POTENTIAL INTERFERENCE PROBLEMS

1. Advanced-Technology Television Receiver

Development work at the FCC is directed toward resolving a number of interference problems involving broadcast television receivers. In a contract with RF Monolithics, Inc., a revised receiver design was developed which employs an IF band of 444-450 MHz. This band is allocated for primary use by Government Radiolocation Service, and high-power military radars are currently operating in this band which are capable of causing the IF interference problems discussed above.

Approaches to minimize this potential problem include, (1) informing the FCC and interested industry officials of the current and planned Government usage in given bands that are being considered for placement of the IF band, and (2) assisting the FCC in evaluating the prototype receiver designed by RF Monolithics.

2. Direct Broadcast Satellite Television Receiver

Recent actions by the FCC are expected to result in the initiation of a new radio service involving the transmission of television programming directly from a geosynchronous satellite to an antenna/receiver system located at an individual residence. When operational, the Broadcasting Satellite Service (BSS) is planned to occupy the 12.2-12.7 GHz band. In reviewing certain prototype designs for the home receivers to be used in this nationwide service, three concerns have been identified: (1) the placement of the first IF band in the 900-1700 MHz region invites potential IF interference problems because high-power radionavigation transmitters are currently operated by the Government in this band; (2) the incorporation of only limited image frequency rejection (40 dB) capability invites potential interference from the high-power radionavigation and radiolocation transmitters operated by the Government at these frequencies; and (3) the use of limited shielding for certain highly sensitive circuits invites potential high-power case-penetration problems caused by ambient radio frequency signals.

Approaches to resolve these potential problems include, (1) the publication of an NTIA assessment on the prototype designs, and (2) providing information regarding Government spectrum usage to industry's receiver designers.

3. Radio Frequency (RF) Lighting Products

A new class of lighting products has been developed which holds the potential for replacing portions of existing incandescent and fluorescent lighting products. Widespread consumer demand could develop for these new products because they appear to require less electrical energy (about 75 percent of the energy required by fluorescent products and only about 25 percent of the energy required by incandescent products) than those products currently used, and the RF products have significantly longer lifetimes than previous lighting products. The design of these new products incorporates a conversion of the 60 Hz source power into an RF signal (in the 20 kHz - 14 MHz frequency range) that is used to accomplish the illumination function in a fluorescent tube. Preliminary tests of sample devices indicate that measurable emissions throughout the band, from 10 kHz - 80 MHz, are generated by these RF lighting products.

4. Power Line Carriers (PLC)

The electric utility industry in the U.S. uses carrier systems to perform communications and control functions throughout the various electric power grids. In these systems, the information is placed on carriers in the 10-490 kHz band which are then superimposed on the 60 kHz electrical power transmission lines that criss-cross the U.S.. Various Government radio services are allocated primary status in selected portions of this band.

The Utilities Telecommunications Council specifically addressed this problem in a petition to the FCC wherein the PLC systems'

susceptibility to interference from Government high-power radio and radionavigation systems was discussed in detail.

Approaches to resolve this problem include, (1) changing the affected PLC's frequencies to avoid interference from Government systems operating in the vicinity of the given electrical power transmission line, (2) placing a footnote in the allocation table which would recognize the existence of the PLC systems, and (3) establishing a notification mechanism between Government agencies planning new operations at a given frequency and the respective industries already using that frequency.

SECTION 4

REVIEW OF POLICY

GENERAL

Communications Act of 1934
48 stat. 1064

"...to make available, so far as possible, to all people of the United States a rapid, efficient, nationwide, and worldwide wire and radio communications services..."

With the above words the U.S. Congress established a national communications objective which served as a basis for federal policies, which have evolved during the last 50 years, regarding the operation of equipment and systems that affect radio communications. The above quote is contained in the Communications Act of 1934 (found in its original form in the United States Statutes, Volume 48, page 1064) where the Congress not only established a national objective but also defined the federal jurisdiction in this area and delegated certain authority for accomplishing the stated objective.

Section 301 of the Act, recently revised by Public Law 97-259, states that it is the purpose of the Act, among other things, to maintain the control of the United States over all the channels of radio transmission. Section 1 of the Act gives the FCC centralized authority to execute and enforce provisions of the Act; however, this authority is limited by Section 305 that delegates the authority for assigning frequencies to Government radio stations to the President. Section 305 also exempts certain apparatus, which belongs to and is operated by the U.S., from FCC action. This two-pronged division of authority still exists and consequently, parallel systems of radio frequency spectrum policies have evolved under the independent authority of the FCC and the President.

Policies established under the authority of the FCC are found primarily in Title 47 of the Code of Federal Regulations (CFR). These regulations, also referred to as the FCC Rules, are divided into 100 numbered Parts that address

various matters regarding the management of non-Government use of the radio frequency spectrum. The portions of the rules containing policies relevant to this study include, (1) Part 15, cited as 47CFR15, that defines the constraints that have been placed on the use and marketing of radio frequency devices operated without licenses (a summary of these constraints is presented in APPENDIX A), and (2) Part 2, cited as 47CFR2.106, that presents the National Table of Frequency Allocations plus the equipment authorization procedures for all electronic products subject to the FCC Rules, cited as 47CFR2, Subpart J.

Policies established under the authority of the President are found primarily in the Manual of Regulations and Procedures for Federal Radio Frequency Management. This document, developed by NTIA under the delegation of authority provided by Executive Order 12046 is referred to as the NTIA Manual. The portions of the Manual containing policies relevant to this study include, (1) Chapter 7 that defines the constraints that have been placed on the Government agencies' use of incidental and restricted radiation devices operated without frequency assignments (a summary is presented in APPENDIX B), and (2) Chapter 4 that presents the International and U.S. National Tables of Frequency Allocations.

Continuing attempts are being made through various coordinating activities to ensure consistency, or at least compatibility, between these two systems of policies. For instance, the question arises as to whether or not the FCC Rules apply to unlicensed devices purchased for Government use. Continuing interference problems of the types noted in Section 3 demonstrate that additional work is still needed to further reduce conflicts between the unlicensed spectrum uses that are subject to policy established by the FCC and the authorized Government spectrum uses that are subject to policy established by NTIA.

Specific approaches for enhancing the effectiveness of federal spectrum management policy are presented in Chapter 5. This section reviews existing policy-focusing on its statutory basis, historical development, organization, and certain key provisions. The review below is intended to provide the context needed for a better understanding of the proposed policy development discussed in Section 5.

REVIEW OF THE DEVELOPMENT OF EXISTING POLICY

In reviewing existing federal policy on the spectrum management of unlicensed spectrum use, it is important to note that past policy development has been guided by various factors including, (1) the above-stated national objective, (2) the manner in which specific technologies are incorporated into distinct classes of devices, and (3) the spectrum users, Government or non-Government, involved in specific spectrum conflicts that have required resolution. Also, it is important to note that although overall policy is defined in various authoritative documents such as statutes, Executive Orders, and Judicial Orders, specific policies regarding given classes of electronic products are defined in the spectrum-usage rules established by the FCC and NTIA. Consequently, the discussion below addresses specific approaches that are used in managing the spectrum and specific rules that are relevant to resolving spectrum conflicts involving authorized Government radio services and unlicensed electronic devices.

Following generally accepted definitions, "communications", in essence, is a transfer of information and "radio communications", in essence, is the transfer of information through means that involve transmitter and receiver operations and use of the radio frequency spectrum. Consequently possible spectrum-management approaches that would facilitate the intended transfer of information include the following:

1. restricting the transmitter's operational capability such that the information is transferred to only the intended receiver--regulation of radio frequency emitters

2. restricting the receiver's operational capability such that the intended receiver is immune to all emissions of radio frequency energy, except those transmissions involving the transfer of the intended information--regulation of receiver susceptibility to radio frequency interference.

Consistent with the above definitions, the Congress has, since 1934, authorized the regulation of emitters to reduce radio frequency interference; however, not until the enactment of Public Law 97-259 in 1982, has the Congress authorized the use of spectrum-management approaches that involve the

regulation of receiver susceptibility. No specific rules have been established for regulating receiver susceptibility; consequently, the discussion in this section will only address the various spectrum-management approaches that involve regulating the emission of radio frequency energy. The specific approaches to be addressed are:

1. allocating specific frequency bands for defined spectrum uses

2. establishing procedures for authorizing users to operate emitters in a manner consistent with the established allocations through the granting of specific station licenses (non-Government), through the assignment of specific operating frequencies (Government), or through the granting of equipment authorizations such as type approval, type acceptance, certification, verification, or registration

3. establishing technical standards for radio frequency energy-emitting devices that restrict the emission spectrum in a manner consistent with the established allocations and that restrict the emission power level in a manner that avoids causing interference with authorized radio services (harmful interference)

4. establishing regulations that require manufacturers to demonstrate, before a given electronic product is marketed, that the product complies with technical standards, issued by the FCC, regarding such products.

Frequency Allocations

International treaties provide the framework for the development of the National Table of Frequency Allocations that guides spectrum usage within the United States.

The FCC's role in the preparation of a National Table of Frequency Allocations is clearly defined in the general powers of the Commission presented in Sections 303(c) and (r) of the Act. These sections state that the "...Commission...as public convenience, interest, or necessity requires shall...Assign bands of frequencies to the various classes of stations...Make such rules and regulations and prescribe such restrictions and conditions...as may be necessary to carry out the provisions of...any international radio or wire communications treaty or convention, or regulations annexed thereto...to which the United States is or may hereafter become a party..."

The NTIA's role in this area is defined in Section 6 of the Department of Commerce Organization Order 25-7 as revised September 14, 1982. This section states that "...the Associate Administrator for Spectrum Management...shall...develop, in cooperation with the FCC, a comprehensive long-range plan for improved management of all electromagnetic spectrum resources including jointly determining the National Table of Frequency Allocations..."

The respective roles of the Executive Branch and the FCC in allocating frequencies were addressed in a 1959 case (Bendix Aviation Corp. vs FCC, 272 F.2nd 533). In that case, the Bendix Aviation Corporation challenged the FCC's denial of its license application for use of frequencies in the 420-450 MHz band that had recently been re-allocated for Government-exclusive use. The re-allocation had been made by the FCC in Memorandum Opinion and Order, without prior notice, in response to a request from the Office of Defense Mobilization (ODM). In making the request, on behalf of the Executive Branch, the ODM indicated that exclusive use of the given frequency band was urgently needed for national defense purposes. The Court upheld the Commission's action stating that the Commission could, under Section 305, consider the frequencies in the requested band to have been assigned by the President and therefore were no longer available to non-Government users.

User Regulation

Sections 301 and 303 (f) of the Act provide the FCC with extensive authority to act toward reducing interference caused by users of the radio frequency spectrum. Section 301 provides the authority for granting, denying, and revoking station licenses plus the authority to ensure termination of unlicensed spectrum use that causes harmful interference to licensed use. Section 303 provides the authority for establishing regulations to prevent interference problems between stations.

Although the 1934 Act provided the FCC with licensing authority, it soon became clear that the licensing of all permitted spectrum uses would be an unreasonable approach for spectrum management. In 1938, regulatory provisions were established for "low-power radio frequency electrical devices" (low-power

rules) which permitted their conditional use of the spectrum. Conditions established include, (1) the maximum-allowable operating range is less than [157,000/(frequency in kHz)] ft. (equivalent to $\lambda/2\pi$) and (2) the maximum-allowable total electromagnetic field strength at this maximum operating distance is 15 microvolts per meter. These "low-power rules" were published in the Federal Register, Volume 3, page 2999, 1938, and are cited as 3FR2999 (1938).

By 1955, the FCC had developed a set of regulations in Part 15 of its rules that addressed a number of devices that were permitted conditional use of the spectrum without a license. The rationale for these regulations, as stated by the FCC, was:

> "...that if radiation can be kept within certain fixed limitations, a general assumption can be made that such operations will normally not cause interference to interstate communications or otherwise have interstate effects bringing such operations within the purview of those which must be licensed under Section 301 of the Communications Act. Accordingly, it is the Commission's position that these operations, as long as they do not exceed certain radiation limitations and do not in particular situations cause actual interference, may lawfully be carried on without a license..." (20FR10056)

Then, again in 1955, consistent with this rationale, the FCC added provisions to Part 15 that, (1) defined the class of "incidental radiation devices", (2) defined certain radio receivers as "restricted radiation devices" (so far as they emitted RF energy) and specified maximum-allowable field strengths for emissions from these devices, (3) defined condition of operation for incidental and restricted radiation devices, and (4) defined the requirements for certification of the radio receivers (20FR10056). Although the technical standards and requirements, introduced in 1955, for certification of radio receivers are significant because they are the precursors of later equipment authorization provisions, the provisions defining the conditions of operation for incidental and restricted radiation devices are particularly significant here. These conditions, now contained in 47CFR15.3 of the FCC rules, still remain as they first appeared in 20FR10057 (1955). They are stated below.

"Persons operating restricted or incidental radiation devices shall not be deemed to have any vested or recognizable right to the continued use of any given frequency, by virture of prior registration or certification of equipment. Operation of these devices is subject to the conditions that no harmful interference is caused and that interference must be accepted that may be caused by other incidental or restricted radiation, industrial scientific or medical equipment, or from any authorized radio services."

The definitions provided, in 1955, for harmful interference, incidental radiation devices, and restricted radiation devices are as follows.

"Harmful interference. Any radiation or induction which endangers the functioning of a Radionavigation Service or of a safety service or obstructs or repeatedly interrupts a radio service operating in accordance with the regulations in Part 2 of this Chapter." (See revision in 47CFR15.4b.)

"Incidental radiation device. A device that radiates radio frequency energy during the course of its operation although the device is not intentionally designed to generate radio frequency energy." (The same is found in 47CFR15.4c.)

"Restricted radiation device. A device in which the generation of radio frequency energy is intentionally incorporated into the design and in which the radio frequency energy is conducted along wires or is radiated, exclusive of transmitters which require licensing under other parts of this chapter and exclusive of devices in which the radio frequency energy is used to produce physical, chemical or biological effects in materials and which are regulated under the provisions of Part 18 of this chapter." (The same is found in 47CFR15.4d.)

Two recent actions by the FCC in Dockets 20780 and 20990 verify that this language continues to be interpreted in a manner such that the operation of incidental and restricted radiation devices is only authorized on a "sufferance basis". The first action addressed computing devices (44FR59530) and the second action addressed control and security-alarm devices (47FR51754). Both actions will be discussed later in this section.

Technical Standards and Marketing Regulation

Since the establishment, in 1938, of the "low-power rules" that allowed radio frequency devices to be operated without a license if their radiated field strength was within prescribed limits, technical standards have been established for diverse classes of unlicensed electronic devices. These technical standards contain provisions for both the allowable functional capabilities of specified devices and their allowable mode of operation. Consequently, these standards must be considered by both manufacturers and users of these devices. In general, these standards can be divided into the following:

1. restrictions on the allowable field strength of the radio frequency energy emitted by the device
2. restrictions on the allowable operating frequencies of the device
3. restrictions on the allowable operating duty cycle of the device
4. restrictions on the allowable form of the information (analog or digital) to be transmitted by the device.

But, under Sections 301 and 303 the Commission's authority was limited in two key areas. It could act against only those unlicensed spectrum users who actually caused harmful interference to authorized spectrum users, and it could only impose mandatory technical standards on licensees. Thus in 1968, with the proliferation of emitting devices causing interference, the Commission sought authority to regulate not only spectrum users but also the marketing of devices that are capable of emitting radio frequency energy in sufficient degree to cause harmful interference to radio communications. The U.S. Congress provided the requested authority by enacting Section 302 of the Act (see APPENDIX C). To implement this legislation, the FCC established new rules known as "marketing regulations" (Report and Order in Docket 18426, 35FR9894) that require manufacturers to, (1) provide assurances to the FCC that newly designed radio frequency devices comply with established standards, and (2) obtain authorization from the FCC before they market the devices. The nature of the authorization required by a given manufacturer depends on the FCC's determination of the expected regulatory costs and the harmful

interference potential associated with the device planned for marketing within the United States. The current provisions in Part 2 of the FCC Rules include the following authorizations:

1. type approval: issued by the FCC following satisfactory testing of one or more sample units by the FCC

2. type acceptance: issued by the FCC for equipment to be operated under a station license following satisfactory review, by the FCC, of representations and test data submitted by the applicant

3. certification: issued by the FCC for unlicensed electronic equipment operated under Part 15 following satisfactory review, by the FCC, of representations and test data submitted by the applicant

4. verification: a procedure established by regulation which requires manufacturers to take necessary steps toward ensuring the compliance of given devices with appropriate technical standards; however, submittal of a sample unit of test data to the FCC is not required unless requested by the Commission

5. registration: a procedure established by regulation which requires manufacturers of telephone-terminal equipment to submit descriptions of certain devices and to obtain a registration number from the FCC for these devices.

The form of authorization applicable to given classes of non-Government unlicensed electronic devices is indicated in APPENDIX A along with a summary of key technical standards.

Recent FCC Actions

Two recent actions by the Commission merit specific attention. One action involves computing devices and the other involved control and security-alarm devices.

Interference to radio and TV reception caused by electronic digital equipment was addressed by the FCC in Docket No. 20780. In the First Report and Order (44FR59530 adopted September 18, 1979) the FCC discussed the general problem of RF interference resulting from incompatible uses of the spectrum and then defined the following two criteria that would guide the development of regulations in this area (44FR59540).

1. The conflicts between users of the spectrum are to be resolved in favor of the most valuable uses.

2. The cost resulting from regulations is to be minimized without unduly compromising given objectives.

Then the FCC stated its decision that the use of the spectrum for radio and television services is more valuable than the use of the spectrum for accommodating the interfering RF signals emitted by computing devices as defined in 47CFR15.4n. Regulations were established, which in addition to placing technical design and marketing restrictions on computer devices, also require that:

> "Notwithstanding the compliance with the technical specifications in this Part. The operation of each computing device is subject to the general conditions of Section 15.3. The operator of a computing device may be required to stop operating his device upon a finding that the device is causing harmful interference and it is in the public interest to stop operation until the interference problem has been corrected." (44FR59543, 47CFR15.803)

Although recognizing that these regulatory restrictions would mean additional costs in the manufacture of computer devices, the FCC concluded that these costs would be less than those incurred by attempts to maintain radio and TV service in the face of unregulated emissions from computer devices.

In the past, the design of most devices resulted in the emission of one or more fundamental frequencies; and measurements could be made in the fundamental portions of the spectrum. Current digital devices emit radio frequency energy over a broad band of frequencies, thus, application of the $\lambda/2\pi$ rules results in a range of measurement distances. For example, at 1000 kHz the distance is 157 feet and at 100 MHz the distance is 1.57 feet (41FR17939). Also, digital devices are used in diverse operating environments along with other electronic devices; both the digital devices and other electronic devices exhibit varying degrees of susceptibility to interference from ambient electromagnetic fields. In addressing this problem,

the FCC has defined two classes of computing devices and has established specific standards, including prescribed measurement distances, for these respective classes of devices (44FR59530, 47CFR15.4).

The second relevant FCC action concerns industry requests for greater flexibility in the design of low-power communications devices used in remote-control and security applications. In the Final Rule of Docket 20990 (46FR55520 adopted October 22, 1981), the FCC, in addition to placing technical design and marketing restrictions on control and security-alarm devices, specifically cautioned manufacturers to consider the susceptibility of their unlicensed electronic devices to interfering signals emitted by authorized high-power Government and non-Government stations. The Commission specifically stated the following.

> "...it should be made clear that devices which are permitted to operate without an individual license under Part 15, must operate on a secondary basis to licensed radio communications services. That is, Part 15 equipment may not cause harmful interference to licensed or Government stations, and must accept any interference received..." (46FR55522)

This action by the Commission also introduced Section 15.204 into FCC Rules which states:

> "...manufacturers may obtain information on Government operations and use it to reduce the susceptibility of their equipment to authorized Government stations. Such information may be obtained from: Director, Spectrum Plans and Policy, National Telecommunications and Information Administration, Department of Commerce..."

Government Operations

Sections 7.8 and 7.9 of the NTIA Manual (summarized in APPENDIX B) contain most of the spectrum-management policies regarding Government-owned and-operated unlicensed electronic devices. Section 7.8 corresponds to Section 15.25 of the FCC rules and contains prohibitions against incidental

radiation devices that cause harmful interference. Section 7.9 corresponds to various portions of Subparts A, D, E, and F of the FCC Rules Part 15 and contains provisions for regulating the technical design and operation of those electronic devices that emit radio frequency energy and are not regulated by any other part of the NTIA Manual. This information, though included in the usage section of the manual, could be more accurately defined as limits or standards.

Both Sections 302 and 305 of the Act exempt, from FCC action, radio stations and certain devices owned and operated by the Government. However, both sections also define certain obligations associated with these exemptions. Section 305 states:

> "...radio stations belonging to and operated by the United States shall not be subject to the provisions of Sections 301 and 303 of this Act. All such Government stations shall use such frequencies as shall be assigned to each or to each class by the President..."

Section 302, enacted in 1968, states:

> "...the provisions of this section shall not be applicable to...devices for use by the Government of the United States or any agency thereof. Devices for use by the Government of the United States or any agency thereof shall be developed, procured, or otherwise acquired, including offshore procurement, under United States Government criteria, standards, or specifications designed to achieve the common objective of reducing interference to radio reception taking into account the unique needs of national defense and security..."

In 1968, the U.S. Congress adopted legislation (H.R. 14910) that became Section 302 and at that time, Congress considered the positions of the FCC and the White House. In a letter from the FCC to the House Committee on Interstate and Foreign Commerce, the FCC stated, to avoid confusion, since, under Section 305f, stations owned and operated by the United States are excluded from the Commission's regulatory jurisdiction, the same exemption should also apply to electronic devices addressed in the proposed

legislation. In a letter from the White House to the Senate Subcommittee on Communications, Mr. J.D. O'Connel stated that:

> "...while the bill as written would exempt from FCC regulations devices manufactured for use by any agency of the Government, it is my intent, should the bill become law, to issue standards to insure that Government equipment meets as a minimum any criteria or standards laid down by the Commission for non-Government equipment..."

This rationale has generally guided the development of Sections 7.8 and 7.9 as NTIA has acted for the President under the delegations of authority included in Executive Order 12046. APPENDIX B presents a summary of key provisions for selected unlicensed electronic devices. Note that the technical standards summarized in APPENDIX B are similar, but not identical, to the technical standards summarized in APPENDIX A (from FCC Rules). Note especially that two classes of devices, control and security-alarm devices and computing devices are addressed in the FCC Rules but are not addressed in the NTIA Manual.

REVISION OF REGULATORY AUTHORITY BY PUBLIC LAW 97-259

A number of revisions to the Communications Act of 1934 are contained in Public Law 97-259 that became effective September 13, 1982; however, this discussion addresses only revisions to Sections 301 and 302.

Section 301--Federal Jurisdiction

Enacted in 1934, this section originally limited the federal jurisdiction to matters involving interstate and foreign radio transmissions plus matters involving interference caused to such transmissions. Public Law 97-259 expanded the federal jurisdiction by stating that it is the purpose of the Act, among other things to "...maintain the control of the United States over all the channels of radio transmission...". According to the report

prepared by the Conference Committee (House Conference Report 97-765, August 19, 1982), the federal jurisdiction was expanded to prevent state and local governments from regulating certain electronic products' susceptibility to radio frequency interference. Such local regulation has been attempted in a limited number of areas and, in the Conference Committee's view, if such action spreads, it could lead to conflicting regulatory policies across the country which would be against the public interest.

Thus, because of the revised Section 301, if radio frequency interference-susceptibility standards are developed, only the Federal Government will have jurisdiction to enforce them.

Section 302--Reducing Susceptibility to Interference

Enacted in 1968, this section originally granted the FCC discretionary authority to regulate the marketing, in the U.S., of devices that are capable of emitting radio frequency energy sufficient to cause harmful interference to radio communications. Although the execution of the expanded authority is also discretionary, Public Law 97-259 now grants the FCC authority to also regulate the marketing, in the U.S., of a newly defined class of electronic products known as "home electronic equipment and systems" to reduce their susceptibility to interference from radio frequency energy. The specific design, or use characteristics, which will determine whether or not a given product is a member of this class of has not been addressed by the U.S. Congress. However, the Conference Committee did indicate that the class would include such items as radio and television receivers, home burglar-alarm and security systems, automatic garage-door openers, electronic organs, record turntables, and stereo/high fidelity amplifier systems (see Figure 1-1).

Thus, the FCC has the authority to establish marketing regulations for the types of unlicensed electronic devices whose susceptibility to interference as been affecting authorized radio services.

The statements of federal policy which are most relevant to this discussion are found in the respective sections of the FCC Rules identified below. They are written as follows:

Section 15.3--General condition of operation

"Persons operating restricted or incidental radiation devices shall not be deemed to have any vested or recognizable right to the continued use of any given frequency, by virtue of prior registration or certification of equipment. Operation of these devices is subject to the conditions that no harmful interference is caused and that interference must be accepted that may be caused by other incidental or restricted radiation devices, industrial, scientific or medical equipment, or from any authorize radio services." (47CFR 15.3)

Section 15.4--General definitions

"...(b) Harmful interference. Any emission, radiation, or induction which endangers the functioning of a Radionavigation Service or of other safety services or seriously degrades, obstructs or repeatedly interrupts a radio communication service operating in accordance with this chapter.

(c) Incidental radiation device. A device that radiates radio frequency energy during the course of its operation although the device is not intentionally designed to generate radio frequency energy.

(d) Restricted radiation device. A device in which the generation of radio frequency energy is intentionally incorporated into the design and in which the radio frequency energy is conducted along wires or is radiated, exclusive of transmitters which require licensing under other parts of this chapter and exclusive of devices in which the radio frequency energy is used to produce physical, chemical or biological effects in materials and which are regulated under the provisions of Part 18 of this chapter..." (47CFR 15.4)

Section 15.132--Labeling and identification requirements
(Low Power Communications Devices: General Requirements)

"(a) A device subject to certification by the Commission for which an application is received on and after May 1, 1981, shall be identified pursuant to Sections 2.925 and 2.1045. In addition, the nameplate or label shall contain the following statement:

This device complies with Part 15 of FCC Rules. Operation of this device is subject ot the following two conditions: (1) This device may not cause harmful interference. (2) This device must accept any interference that may cause undesired operation." (47CFR15.132)

[Although the condition has been slightly revised to read: "...(2) this device must accept any interference that may be received, including interference that may cause undesired operation", similar labeling requirements apply to telemetering devices (Section 15.178b), biomedical telemetering devices (Section 15.178c), radio control for door openers (Section 15.186), control and security-alarm devices (Section 15.211), field-disturbance sensors (Section 15.314), auditory-assistance devices (Section 15.371), and television interface devices (Section 15.622).]

LIMITATIONS ON APPLYING PRESENT POLICY

In summary, the above-stated policy means the unlicensed electronic devices may not cause interference and their users must accept any interference. But, the resolution of radio frequency interference problems through the Governments' application of this established policy is often difficult when the individual operation of numerous, widely dispersed, unlicensed devices is causing the problem and when significant risk exists that widespread unfavorable public reaction will result from continuing the authorized Government radio-service operations involved in the problem. For example, in cases where the cost of locating the individual offending devices is significant, the Government agency frequently finds it less costly to change its operations. In other cases where individual consumers, after finding that the intolerable degradation in performance of a given unlicensed device is caused by a Government transmitter, take action through political

channels, the Government agency operating the authorized transmitter frequently has no alternative but to change its operations despite the inconvenience and cost to the Government. Therefore, the Government frequently waives its rights of protected-spectrum status provided by the policy and incurs significant additional costs to ensure continued execution of essential Government functions.

The ubiquitous use of unlicensed devices that are subject to the above-stated policy is not likely to be halted because American society is becoming increasingly dependent on consumer electronic goods and will continue to demand them from manufacturers. Also, the continued responsiveness of the Government to concerted action from voter constituencies is vital toward maintaining the American democracy. Thus, it would appear the avoidance of spectrum conflicts demands urgent attention as a viable means for reducing the costs incurred by the Government as a result of present policy limitations. Alternatives to avoid certain spectrum conflicts are discussed in Section 5.

AMBIGUITIES IN APPLYING PRESENT POLICY

The conditions of operation stated in Section 15.3 clearly apply only to the two classes of devices identified as "restricted or incidental radiation devices". Consequently, before the present policy can be applied to a given device, it is necessary to determine whether the device is a member of either of these two device classes. Turning to the definitions for these classes, the distinguishing characteristic dividing these classes appears to be whether, or not, the radio frequency energy emission was intended as an essential part of the device's design and function. In restricted radiation devices, radio frequency energy emissions are essential to the device's operation, whereas, in incidental radiation devices, the emission is unintentional. The characteristic common to both classes, however, is the emission of some radio frequency energy.

The question arises, "What is the threshold (field strength) for the energy emitted which must be exceeded before a given device becomes subject to Section 15.3 and its user '....must accept any interference that may be received, including interference that may cause undesired operation'?"

The FCC Rules do not appear to establish such a threshold. Consequently, it is possible to conclude that any device that emits radio frequency energy is subject to the condition in Section 15.3, and its user must accept any interference received. A major problem with this conclusion is the difficulty in convincing the user of a certain device, such as stereo amplifiers, that all interference from authorized radio services must be accepted.

Section 302 of the Act, enacted in 1968, provides the FCC with authority to "...make reasonable regulations governing the interference potential of devices that, in their operation, are capable of emitting radio frequency energy...in sufficient degree to cause harmful interference to radio communications..." A threshold does appear to exist because the FCC's authority is limited to establishing regulations regarding only those devices that are capable of causing harmful interference. Consequently, it is possible to conclude that the applicability of the operating conditions in Section 15.3 to a given device depends on how the device is used. Problems arising from this conclusion include the following: (1) Section 302 of the Act was enacted in 1968 and the FCC rule in Section 15.3 was established by a Commission Order in 1955, consequently, the use of Section 302 for interpreting the intent of the rule is necessarily limited, and (2) some devices have multiple uses in diverse operating environments, consequently, confusion would result when attempting to enforce a rule that is only applicable in limited cases.

Section 301 of the Act, enacted in 1934, established federal jurisdiction over all the channels of interstate and foreign radio transmission. Consequently, it is possible to conclude that in 1955 the Commission held the authority to regulate radio transmissions but did not hold the authority to regulate the susceptibility of devices to interfering transmissions. Acceptance of this conclusion would void the condition (Section 15.3) that users of incidental and restricted radiation devices must accept all interference. A major problem with this conclusion is the severe limitation it places on the Commission's authority to "...carry out the provisions of this Act..." (Section 303f of the Act).

Section 302 of the Act, as received in 1982, provides the Comission with authority for "...establishing minimum performance standards for home

electronic equipment and systems to reduce their susceptibility to interference from radio frequency energy...". Consequently, it is possible to conclude that the Commissions' rule in Section 15.3 now potentially enjoys an enhanced statutory basis relative to certain devices included in the class now known as "home electronic equipment and systems." Does this authority, specifically directed toward home electronic equipment, mean that similar authority does not exist over the susceptibility of other unlicensed receivers? Also, if the FCC determines that it will not regulate certain types of receivers, can the sufference rule be applied to those systems? These questions show, to some extent, the difficulty in interpreting the rules.

SECTION 5

APPROACHES FOR SPECTRUM MANAGEMENT OF UNLICENSED DEVICES

GENERAL

Any approach to managing the use of unlicensed devices will have associated costs and benefits. These costs and benefits will affect Government agencies, manufacturers, and consumers to varying degrees. An in depth cost/benefit analysis is required in order to recommend use of a specific approach, but such a rigorous study is beyond the scope of this effort. Nevertheless, before suggesting any actions, this report will identify, in qualitative terms, the costs and benefits involved with each alternative, thereby raising the awareness level concerning the relative impact of those approaches.

The costs to NTIA and operating Government agencies required to implement a specific approach include the expenditure of resources (used herein to mean money, time, and manpower), modification of existing radio operations, and greater regulation. When the incidence of interference is decreased, consumers, as well as the Government, benefit.

For manufacturers, various approaches also require expenditure of resources to design, manufacture, and test the product. Some of the approaches afford manufacturers a choice. Other costs are the administrative burden of regulatory compliance and less flexibility in the design of a product. How much of the price increase is passed on to the consumer and how much is absorbed by the manufacturer, cannot be estimated as it varies for different products. However, these approaches would result in some benefits to manufacturers such as: information on the operating electromagnetic environment, greater certainty on the likelihood of interference, greater customer satisfaction, and fewer interference complaints.

Consumers would benefit by being able to choose products with greater immunity to interference. Increased price of the product and an increased sophistication in purchasing decisions are the consumer costs for achieving the benefits.

APPROACH 1 - MAINTAIN CURRENT PROCEDURES

Current procedures emphasize direct discussion between Government spectrum users and the owners of unlicensed devices in conflict. Costs and benefits cannot be fully analyzed because there is insufficient problem documentation. Some of the documented cases do, however, reveal that the rights associated with frequency assignment do not guarantee against Government users absorbing some of the costs of interference resolution. In some cases, where public pressure has been particularly high, the Government has lost the use of its frequencies or borne the entire bill for resolving a problem. Unchanged procedures, combined with increased spectrum use by unlicensed systems, will certainly lead to increased costs.

Keeping the status quo does have benefits in that no costly system of regulation is required, and though there is evidence of current cost to the Government user, more information is required to show that those costs are greater than those of regulation. Although current regulations appear to provide sufficient protection for authorized users, the costs of cooperation have evidently been less, in many cases, than the costs in public relations related to evoking these regulations.

APPROACH 2 - CHARACTERIZATION OF RADIO FREQUENCY OPERATIONS

Government Operations

Section 15.204 of the FCC Rules contains the following provision

"Receiver susceptibility to interference.

(a) As stated in Section 15.203, a low power communication receiver must operate on a sufferance basis; that is, it is not offered any protection by the Commission should an authorized high power (Government or non-Government) radio station cause undesired operation of the receiver. Manufacturers are therefore encouraged to

consider the susceptibility of the receiver in the design of their systems, particularly for those systems that operate in the frequency bands identified in Section 2.106 of this chapter for Government operations.

(b) Manufacturers may obtain information on Government operations and use it to reduce the susceptibility of their equipment to authorized Government stations. Such information may be obtained from: Director, Spectrum Plans and Policy, National Telecommunications and Information Administration, Department of Commerce, Washington, D.C. 20230."

Since the inclusion of Secton 15.204(b) in the FCC Rules, approximately 20 responses to industry requests for information have been prepared by NTIA. The reaction by industry has been favorable. Figure 5-1 is an example of the standardized form that has been developed to provide expeditious responses to the requests received.

These rules, however, only apply to radio-control and security-alarm devices. Similar information would have to be included in the other sections dealing with susceptibility of unlicensed devices.

A weakness in this approach is the constant change in Government equipment characteristics as band use is upgraded and/or expanded for new applications. Typically, such change is gradual and, therefore, the common characteristics compile by the Government should be representative of the band for a reasonable period of time. The cost to the Government would be a result of the number of information requests and the frequency of required updates.

The RSMS Van is frequently used to measure spectrum occupancy of Government operations. Primarily, these measurements have been done near large metropolitan areas where the greatest use of unlicensed devices exists.

Since this work is already being done, the only additional cost to the Government would be related to putting the information into a form usable by industry.

DATE: January 6, 1982

Summary Characterization of the 225-328.6 MHz Frequency Band

Frequency Band: 225-328.6 MHz

Primary Government Allocation: FIXED and MOBILE

Primary non-Government Allocation: NONE

Secondary Government Allocation: NONE

Secondary non-Government Allocation: NONE

Representative Technical Characteristics of Government Uses

Major Government Use	Transmitter Power (dBm) (Average)	Modulation	Necessary* Bandwidth	Transmitter Antenna Gain (dBi)	Receiver Sensitivity(dBm)
AIR-TO-GROUND COMMUNICATION	30-60 (Typical 50)	AMPLITUDE	6 kHz	2	-101
GROUND-TO-AIR	30-73 (Typical 50)	AMPLITUDE	6 kHz	6-8	-98 (typical)
MILITARY SATELLITE OPERATIONS	43-50 (SPACE) 40-60 (EARTH)	FREQUENCY FREQUENCY	5, 25, 500 kHz 5, 25, 500 kHz	2 (SPACE) 12 to 26 (EARTH)	-131 (typical) -135 (typical)
RADIO RELAY	30-60 (Typical 50)	FREQUENCY	10 to 600 kHz	8	-100

*Depending upon the modulation type, values of necessary bandwidth are at points 20-40 dB below the peak emission spectrum level.

Area of Deployment: Mobile operations are on military aircraft in the proximity of military and civilian airports. Satellite operations include terrestrial stations operating on land, air and sea. Radar relay stations are located at military installations scattered throughout the United States.

Typical Operation: Operationally, this band is used by the military as the primary air-to-ground communications band, with the FAA providing air traffic control services to the military on specific frequencies at certain designated military and civilian airports. Geostationary satellites provide a communication link between earth stations to support operational military communications. A limited number of relay stations are used for intersite communications on military bases.

CONTINUED

Figure 5-1. Form used in compiling Government equipment characteristics in response to industry requests. (Page 1 of 2)

COMMENTS: The following footnotes to the National Table of Frequency Allocations apply:

308A The band 240-328.6 MHz may also be used by the mobile-satellite service. The use and development of this service shall be subject to agreement between the administrations concerned and those having services operating in accordance with the Table, which may be affected.

310 Radio astronomy observations in the band 322-328.5 MHz are carried out in a number of countries under national arrangements. Administrations should bear in mind the needs of the radio astronomy service in using this band.

US98 The frequency 243 MHz is the frequency in this band for use by Government and non-Government survival craft stations and equipment used for survival purposes.

G30 In the band 225-328.6 MHz, the fixed and mobile services are limited primarily to operations by the military services.

G100 The mobile satellite service within the band 240.0-328.6 MHz is limited to military systems.

The following provision of Part 15 of the FCC's Rules and Regulations also applies:

Section 15.205 Technical Standards

(a) Emission of RF energy from the transmitter as well as the receiver part of the control shall not fall within the band 240-285 MHz. A radiation level below 15 μV/m at 3 meters will be considered to meet this requirement.

Figure 5-1. Page 2 of 2.

Unlicensed Electronic Device Operations

The measurement of the transmitted spectrum of certain unlicensed devices would also be beneficial. Such "signatures", when made available to Government operators, could help in the prediction of possible interference to their equipment and aid in the selection of an operating frequency or system components. The measurements may also be used to identify the specific source of interference coming from the unlicensed electronic device and thereby help industry take corrective action to bring their products back in line with the FCC Part 15 sufferance rule.

These measurements could be performed with the RSMS Van. Costs to the Government would depend upon the number and location of devices to be measured.

APPROACH 3 - ASSISTANCE IN INTERFERENCE RESOLUTION

The Government communications user, in seeking to correct interference at the local level, will have varying degrees of success in interference-source identification and may require support in negotiations of conflict resolution.

The NTIA RSMS Van can fulfill the interference-measurement requirement. The use of this system, though effective, is limited by scheduling and funding. Small portable measuring systems are more adaptable to this use, however, significant costs would be accrued through the purchase, maintenance, and deployment of such equipment but its use would help in determining the exact nature of a particular interaction.

Because NTIA does not oversee the use of unlicensed devices operated by the private sector, no authority exists to ensure the protection of authorized use. In situations where negotiations do not result in a solution satisfactory to Government stations, contact should be made for FCC assistance. FCC involvement may, in those cases, provide the necessary authority to solve the problem. Little cost would be associated with this approach and the coordination may actually improve the NTIA/FCC relationship.

APPROACH 4 - INFORMATION PROGRAM

Communications with the FCC and manufacturers will help to develop awareness of existing problems. Although interference to, and from, Government operations is only a portion of their concern, problems between authorized non-Government spectrum users and unlicensed devices are similar. Interest in this area is being expressed by the private sector through FCC working groups, papers, and conferences. Also, the Frequency Management Advisory Council recently reviewed this subject resulting in APPENDIX D. NTIA participation in these arenas would facilitate discussion of the problem. Ongoing costs would be absorbed by NTIA through the use of personnel. The amount of attention given, and benefit received, will reflect the seriousness of the problem, as demonstrated by documentation, and the skill with which the problem is communicated.

APPROACH 5 - ALLOCATION OF SPECTRUM FOR CERTAIN UNLICENSED DEVICES

In some cases, specifically various types of low-power communications devices where transmitting and receiving frequencies will be known, spectrum could be allocated the same as for currently authorized services. Such frequencies have been provided for ISM systems and are being considered for the cordless telephone.

Costs would involve the loss of otherwise available frequencies as well as time and money expended to select frequencies. Benefits would result through the avoidance of interference involving the operating frequencies of these systems. No improvement would be experienced in interference related to an undesired or unintended radiation.

APPROACH 6 - VOLUNTARY INDUSTRY STANDARDS

Encouraging industry to develop and adhere to voluntary standards is an alternative that also avoids greater regulation by Government. Decision making, regarding interference immunity, is vested in those that design and manufacture the devices. However, this alternative is based on the assumption

that all manufacturers, including those in foreign countries, will perceive it in their best interest to participate in such a program. Voluntary standardization was an alternative discussed in the FCC's Further NOI in General Docket No. 78-369.

To work effectively, a voluntary program must consist of two items. The first item would be for an industry association to recognize the interference problem, to analyze interference interaction of a device, to establish a given level for interference prevention, and to establish measurement procedures for determining compliance with the standard. This would "set up" the standards. An important element of this part would be a full understanding, by the developers of the standard, of the technical characteristics of possible sources and victims of interference. The second item would be voluntary participation in the program by as many manufacturers of a device as possible. This would mean that domestic manufacturers, foreign manufacturers that export to the U.S., and manufacturers that produce in the U.S. under license, would design their devices to give at least a certain level of interference protection.

Establishment of voluntary standards is a time consuming-procedure. It requires the consensus of all interested manufacturers; a consensus that is not easily attained. In certain rapidly changing technologies, industry leaders would not be interested in developing standards until their market share is firmly established. Efforts in this area can be construed as market manipulation putting manufacturers in the position of determining product sales success instead of consumers.

There are also various levels within the category of voluntary standards. For example, the Electronic Industries Association (EIA), which is a non-profit organization representing U.S. manufacturers of electronic products, promulgates guidelines and standards. Guidelines contain technical information deemed to be of value to industry and are published without rigorous public review. On the other hand, standards are more binding and they are promulgated only after resolution of all comments. Within EIA, guidelines have been promulgated dealing with television-receiver susceptibility to interference. However, other Part 15 devices such as garage-door openers, cordless telephones, and others have not received the same attention. No EIA guidelines or standards exist for these Part 15

devices. In part, the lack of standards can be attributed to the industry structure that is composed of many small firms that cannot support extensive participation in association work.

It should be noted that the Communications Division of EIA created a Personal Radio Section to address the problems of the cordless-telephone industry (Schimmel, 1981). Developing technical standards and securing spectrum access are two of the prime concerns of the Personal Radio Section. Thus, a forum has been established for manufacturers of cordless telephones to voluntarily develop interference-immunity standards. In this case, NTIA and the FCC are presented with an ideal opportunity to evaluate the feasibility and viability of voluntary industry standards as an effective alternative for reducing the interference susceptibility of Part 15 devices.

APPROACH 7 - INFORMING UNLICENSED SPECTRUM USERS OF EXISTING POLICY

Labeling requirements in the FCC Rules specify that certain unlicensed electronic devices must display a nameplate containing the following information:

> "This device complies with FCC Rules Part 15. Operation is subject to the following conditions: (1) This device may not cause harmful interference and (2) this device must accept any interference that may be received, including interference that may cause undesired operation."

Specific types of devices that must display this statement of policy--and one can assume that the user is thereby informed--include telemetering devices (15.178b), biomedical telemetering devices (15.178c), radio control for door openers (15.186), control and security-alarm devices (15.211), and field-disturbance sensors (15.622). Only those devices that are intended by their designers to emit radio frequency energy are currently covered by this labeling requirement. However, it would appear that the same approach could be effective by similarly informing users of all unlicensed emitters and electronic devices that prove to be particularly susceptible to radio frequency interference.

Costs in this case are born by the manufacturer and consumer. Benefits will be derived from these labels in cases where consumer interest in a product is weak, and application of the sufferance rules only requires a little support in order to strengthen the Government position.

APPROACH 8 - PRODUCT LABELING AND GRADING

Providing consumers with information on the interference immunity of the products that they buy is an alternative that stops short of regulating receivers. With the added information on immunity, provided by the manufacturer, consumers could choose between interference resistant products (those with greater electronic complexity) at a higher price and more susceptible products at a lower price. Avoiding interference would be the responsibility of the consumer exercised through the purchasing decision. A product-labeling alternative was discussed in NTIA's testimony on Senate Bill S.929, the FCC's Further NOI in General Docket 78-369, and the staff study (Jackson, 1977) of the Subcommittee on Communications (Committee on Interstate and Foreign Commerce, House of Representatives).

This alternative could be voluntary and self-regulating if all of the affected manufacturers would agree to participate, or it could be mandated by legislation. The FCC described the labeling and grading alternative as:

> "...under such an option the Commission could devise susceptibility standards that determined a minimum level of performance for a product in the presence of harmful interference and then specify labels based upon how a device performed relative to the standard. In addition, the Commission could grade the radio environment so that consumers could match the immunity grade of the equipment they purchase with the predicted need for immunity where they live." (FCC, 1981)

Canada's and Australia's Department of Communications are moving towards a voluntary product-labeling and grading program. In their Advisory Bulletin on Immunity, the Canadian Department of Communications characterized the radio environment in populated areas in the frequency band 0.014-10,000 MHz.

The Department encourages designers and manufacturers to ensure that their equipment is designed to operate in the radio environment. Based on the description of the usual Canadian environment, three grades of immunity have been derived. Grade 1 means that interference and performance degradation are likely in populated areas. Grade 3 is the highest degree of immunity, and performance degradation would only be expected in very arduous circumstances. After uniform immunity-measurement techniques have been established, the Department intends to encourage manufacturers to label their equipment with the immunity grades.

Grading the immunity of some products to interference is currently being done by organizations such as Consumer's Union. In its Consumers Report, Consumer's Union rates the interference immunity of television receivers to CB interference and compares results relative to other brands under test. Of all, only television receivers have been tested for interference immunity. Other devices contain only performance tests and not interference-rejection ratings.

APPROACH 9 - RECEIVER REGULATION

Establishing interference performance standards for receivers is an alternative that was proposed in Congress by Senate Bill S.929 and that was considered by the FCC in General Docket 78-369 (FCC, 1981a). Performance standards would specify two things: minimum levels of receiver susceptibility which equipment manufacturers would have to provide and methods for manufacturers to demonstrate compliance.

S.929 was not the first piece of legislation to contain provisions that would grant the FCC authority to establish performance standards for receivers to reduce their susceptibility to interference. Bills of similar intent were introduced in the 95th Congress by Congressman Vanik (HR.7052) and Senator Goldwater (S.864). These bills were not voted out of committee and therefore never considered by the full House or Senate. Unlike its predecessors, S.929 was favorably voted out of the Communications Subcommittee and the Committee on Commerce, Science, and Transportation. On September 25, 1981, S.929 passed the full Senate and was sent for consideration to the House of

Representatives. No similar bill was introduced in the House and the Subcommittee on Telecommunications, Consumer Protection, and Finance did not take up the Senate version.

In general, interference-performance standards are definitions of a receiver's ability to discriminate against unwanted signals and to operate without degradation in the presence of such signals. The receivers ability to discriminate, therefore, is its immunity to interference.

Since various devices degrade at different interference levels, the immunity levels would have to be tailored to the device. For example, a garage-door opener and a cordless telephone would degrade at different interference-signal levels. Specified signal strengths would also vary as a function of frequency so that the different interference mechanisms described in Section 3 (i.e. co-channel, adjacent channel, harmonic) would be adequately considered.

Quite obviously, the "regulated" susceptibility levels would have a direct impact on the design and cost of a device. The lower the degree of susceptibility that is required, the greater the complexity of design and cost. In selecting the levels that must be met, a regulatory agency would have to be familiar with the operation of various classes of devices, the variation in expected signal strength in the intended environment of operation, and the degree of interference protection that should be afforded each user. Compliance would be secured through the equipment-authorization process, including appropriate measurements by the manufacturer and submission of a report.

Susceptibility standards are being instituted in the Federal Republic of Germany (FRG) for broadcasting receivers. To obtain type-approval authorization, television and radio receivers must operate without degradation when subjected to adjacent-band field strengths of 3 V/m. Receivers may be marketed without type approval, but if interference is experienced, the user has no recourse and must accept the interference. Devices without type approval have no authority to operate, which means that they are not protected from interference.

In considering HR3239, which the Congress enacted as Public Law 97-259, the Conference Committee examined alternative approaches for addressing

persistent public complaints regarding radio frequency interference (RFI) to consumer electronic goods such as television and radio receivers. Its report states:

> "...The Conferees wish to emphasize that it was its hope that voluntary efforts by manufacturers to reduce RFI when possible, as opposed to the use of Government regulation, would be sufficient. Devices designed and marketed for use in a commercial environment normally include necessary protection against interference and do not require Commission regulation. In the market for home devices, however, good faith industry attempts to solve this interference problem have not always been as successful. Thus, in view of complaints regarding home devices, the Conferees believe that Commission authority to impose appropriate regulations on home electronic equipment and systems is now necessary to insure that consumers' home electronic equipment and systems will not be subject to malfunction due to RFI..." (House Conference Report 97-767. p32).

But, the creation of incentives for encouraging compliance with federal standards and the enforcement of regulations can be costly. The magnitude of these enforcement costs, generally, is directly proportional to the degree that significant burdens imposed by standard, or regulation, <u>are not</u> borne by its beneficiaries. The Conference Committee was also concerned about costs and stated in its report that:

> "...The Conferees expect the Commission to exercise the authority granted herein as it has exercised the authority granted under Section 302 of the Communications Act of 1934, by balancing the cost of improving the performance of a device to particular levels against the benefit to be gained from requiring manufacturers to meet standards of various levels of stringency. In so doing, the Conferees expect the number of interference complaints recorded and investigated by the Commission to be significantly reduced..."

Prohibiting the marketing of non-standard products clearly will require establishing regulations and the authority to enforce them. While this option

is available, and may be exercised in the future, significant work remains to be accomplished first regarding the development and implementation of standards.

APPROACH 10 - PRODUCT WARRANTY

Establishing a program of product warranty is an option mentioned in the staff study (Jackson, 1977) of the Subcommittee on Communications (Committee on Interstate and Foreign Commerce, House of Representatives). Under this program, all consumer-electronics products would be required, by law, to operate in their intended electromagnetic environments without harmful degradation unless a specific disclaimer is issued to the purchaser by the manufacturer or retailer.

Normal warranties guarantee the original purchaser, for a specified period of time, that the product will be free of manufacturing defects. If service is required during the warranty period, the seller will repair or replace the product without charge upon proof of purchase. Warranties are a guarantee of workmanship and components, factors over which manufacturers have control. By Federal law, warranties also give the purchaser specific legal rights.

An "interference warranty" program would bestow on the purchaser even greater legal rights. In effect, it would go beyond defect-free workmanship by guaranteeing performance of a product under any operating conditions and in any electromagnetic environment. "Interference warranties" would require manufacturers to design their products to be immune to interference even under the worst-case conditions. The warranty disclaimer would be a way of giving the manufacturer, retailer, and purchaser a choice. The choice would be to provide, or purchase, (as may be applicable) a product that has guaranteed interference-free performance. Additionally, the disclaimer would make the purchaser aware of interference problems and thereby bring attention to the choice available.

A warranty program could tend to freeze the characteristics of Government and non-Government equipment in certain frequency bands so that the interference potential to the consumer-electronic equipment would not

change. This could potentially handicap Government systems in bands that change their characteristics with improved technology and required mission. However, if the warranty is sufficiently "worst case", changes to the equipment would probably have little effect on the interference-susceptibility levels.

An "interference warranty" would be more demanding on manufacturers than product labeling or receiver regulation. Under those alternatives, regulatory agencies would provide manufacturers with uniform informational support. Under an "interference warranty" the obligation would be on each manufacturer to obtain all necessary information.

This alternative would require new legislative authority, and to be workable, a significant number of manufacturers would have to provide the warranties. Warranties would also have to be applicable to all consumer-electronics devices regardless of their operating frequencies (i.e. Government or non-Government allocated bands).

APPROACH 11 - LIABILITY

Liability rules would act to shift the responsibility for interference control from Government to the affected parties by specifying the party responsible for interference and by identifying the penalties that would be incurred if interference complaints were not resolved. Liability for taking steps to eliminate interference could be assigned to those who transmit signals that interfere, or manufacturers who produce receivers that are used in consumer-electronics devices. Numerous methods could be used to eliminate the interference such as change in operations or transmission characteristics, financial compensation, and individually tailored technical fixes. The method chosen would depend upon the parties involved.

Assigning liability for interference and defining the limitations of responsibility would, in some cases, require legislation. Settling contested cases would unquestionably lead to greater involvement by the judicial system in even the most routine of interference complaints. Therefore, the judicial system, in generating a body of case law, and the applicable law of torts would be establishing spectrum management policies and procedures.

Although liability may be a reasonable alternative for settling civil disputes of interference, it may not be applicable to interactions involving Government operations. Liability seems best suited to cases of amateur or CB interference to television receivers; cases that involve services of "comparable" public interest. Government operations that support achievement of national goals are not comparable to the conveniences afforded by unlicensed electronic devices. Therefore, arbitrarily establishing liability and responsibility to one user or manufacturer, has resultant inequities in the resolution of interference.

EVALUATION OF APPROACHES

In evaluating the alternatives, it should be kept in mind that NTIA is looking for a reasonable solution that addresses the Government's immediate concern of interference immunity without imposing needless regulatory burden.

In general, Approaches 1-11 were presented in their order of increasing regulatory obligation of manufacturers. Alternatives, such as maintaining current procedures, voluntary standards, characterization of Government radio operations, or allocation status, impose less regulatory requirements on manufacturers than would product labeling, receiver regulation, product warranty or liability. Although for some alternatives a manufacturer's regulatory obligations increase, Government radiocommunication users and consumers would not necessarily reap benefits in the reduction of the incidence of interference. Alternatives that give manufacturers and consumers a choice (i.e. voluntary standards, characterization, or product labeling) may not necessarily result in the "best or proper" choices and thereby, no change in the incidence of interference involving Government radio operations. Likewise, voluntary alternatives in which NTIA expends resources, such as characterization, may be ignored or not implemented by industry once again resulting in no benefits for consumers or Government radio users. Consumers could benefit, albeit at a cost, from any of the alternatives. However, it is not possible to estimate whether the benefits would be greater for the more restrictive alternatives. For example, the incidence of interference could be decreased, at less cost to all parties, by giving allocation status to some

unlicensed electronic devices rather than from an alternative that would regulate their associated receivers.

Alternatives requiring new legislative authority would have to be applied equally to systems operating in Government, as well as non-Government, frequency bands. Joint administration, or coordination, would be required with the FCC. These alternatives would be politically demanding to achieve and they would involve new spectrum-management procedures for both the FCC and NTIA. New procedures such as these would require a great deal of time to implement.

In the absence of a rigorous cost/benefit analysis, a pragmatic course of action would be to implement alternatives that would distribute the costs among all parties with a view towards a general reduction of the problem. Voluntary action by all parties would be a first attempt at addressing the problem.

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APPENDIX A

OPERATING RESTRICTIONS FOR UNLICENSED ELECTRONIC DEVICES - NON-GOVERNMENT

TABLE A-1

(Page 1 of 6)

OPERATING RESTRICTIONS FOR
UNLICENSED ELECTRONIC DEVICES - NON-GOVERNMENT
(TAKEN FROM PART 15 OF THE FCC RULES
- SPECIFIC SECTIONS ARE REFERENCED)

Class of Device	Allowable Operating Bands	Allowable Field Strength	Measurement Distance	Equipment Authorization Reqmt.
√Incidental Radiation Device (15.25)	----------no specific restrictions specified but must not cause harmful interference			
√Restricted Radiation Device (15.7)	All Bands 10 kHz - 3,000 GHz	15 μV/m	157.000/F(kHz) ft	see provisions for specific classes of devices
√-Low Power Communications Device General (15.101)	10 kHz - 490 kHz	2400/F(kHz) μV/m	300m	see provisions for specific classes of devices
	510 - 1600 kHz	2400/F(kHz) μV/m	30m	see provisions for specific classes of devices
	160 - 190 kHz	rf power input to final stage ≤ 1 watt		see provisions for specific classes of devices
	510 - 1600 kHz	rf power input to final stage ≤ 100 milliwatts		see provisions for specific classes of devices
		rf signal between 510 kHz to 1600 kHz conducted into power network ≤ 200 μ volts		
o Cordless telephone (15.114) (to operate until 1/Jan/86)	26.985-27.265 MHz six channels, 20 kHz wide	c) rf signal below 25 MHz conducted into power net work ≤ 100 volts		registration
		a) 50,000 μV/m within authorized band	3m	
		b) 1000 μV/m between 10kHz-50kHz from carrier	3m	
		d) 300 μV/m above 50kHz from carrier	3m	
		e) all emissions greater than 30 μV/m must be reported	3m	

√ indicates corresponding provisions are included in NTIA rules

TABLE A-1

(Page 2 of 6)

Class of Device	Allowable Operating Band	Allowable Field Strength	Measurement Distance	Equipment Authorization Reqmt.
o Operation in 26.97-27.27 MHz band (to be operated until 18/Sept./83) (15.115)	26.97-27.27 MHz	rf power input to final stage < 100 milliwatts		Currently None
o Non-voice device (15.116)	26.99-27.26 MHz six channels, 20 kHz wide	≤ 10,000 μV/m within authorized band	3m	Currently None
		≤ 500 μV/m within 10 kHz from carrier	3m	
		≤ 50 μV/m between 10 - 1000 MHz	3m	
		rf signal below 25 MHz conducted into power network ≤ 100 μ volts		
o Operation in 49.82-49.90 MHz band (15.117-119)	49.82-49.90 MHz five channels, 20 kHz wide	≤ 10,000 μV/m within authorized band	3m	
		≤ 500 μV/m within 10 kHz of carrier	3m	
		≤ 50 μV/m between 25-100 MHz	3m	
		rf signal below 25 MHz conducted into power network ≤ 100 μ volts		
o Operation above 70 MHz to operate until 1/Sept/83 (15.120)	70-130 MHz	50 μV/m	30m	Currently None
	130-174 MHz	50-150 μV/m**	30m	
	174-260 MHz	150	30m	
	260-470	150-500**	30m	
	470 & above	500	30m	

**linear interpolation

TABLE A-1

(Page 3 of 6)

Class of Device	Allowable Operating Band	Allowable Field Strength	Measurement Distance	Equipment Authorization Reqmt.
o Periodic operation in bands 40.66-40.70 & above 70 MHz (15.122)	40.66-40.70 MHz	1000 μV/m on carrier 100 μV/m off carrier	3m	Currently None
	70 to 130	500 on carrier 50 off carrier	3m	
	130-174	500-1500 on carrier** 50-150 off carrier**	3m	
	174-260	1500 on carrier 150 off carrier	3m 3m	
	260 to 470	1500-5000 on carrier 150-500 off carrier	3m	
	470 & above	5000 on carrier 500 off carrier	3m	
		rf signal between 450 kHz and 30 MHz conducted into power network ≤ 250 volts		
o Wireless microphone (15.162)	88-108 MHz	-50 μV/m within 200 kHz channel	15m	Type Approval
		-40 μV/m outside 200 kHz channel	3m	Certified
(15.161)	any band provided requirements of sections 15.101 to 15.143 are satisfied			Certified
o Telemetering device (15.171)	38-41 MHz	10 μV/m within 200 kHz channel	15m	Certified
		10 μV/m outside 200 kHz channel	3m	
	88-108 MHz	50 μV/m within 200 kHz channel	15m	Type Approval
		40 μV/m outside 200 kHz channel	3m	

**linear interpolation

TABLE A-1

(Page 4 of 6)

Class of Device	Allowable Operating Band	Allowable Field Strength	Measurement Distance	Equipment Authorization Reqmt.
o Telemetering device (cont.) (15.176)	174-216 MHz	150 μV/m withing 200 kHz channel	30m	Certified
		15 μV/m outside 200 kHz channel	30m	
(15.171)	any band provided requirements of sections 15.101 to 15.143 are satisfied			Identification (15.178)
o Radio Control for Door Opener (15.181)	any band provided requirements of sections 15.101 to 15.143 are satisfied			Currently None
o Radio Control for Door Opener Operating Above 70 MHz to be operated until 1/Sept/83 (15.184)	70-130	125 μV/m	30m	Certified
	130-174	125-375**	30m	
	174-260	375	30m	
	260-470	375-1250**	30m	
	above 470 section 15.184 specifies bands where operation is unauthorized	1250	30m	
o Control and Security Alarm Devices** (15.201)	any band, unless excluded by 15.205, provided requirements of sections 15.101 to 15.143 are satisfied			Certified

**linear interpolation

TABLE A-1

(Page 5 of 6)

Class of Device	Allowable Operating Band	Allowable Field Strength	Measurement Distance	Equipment Authorization Reqmt.
o Control and Security Alarm Devices (cont.) (15.201)	40.66-40.70 MHz	2250 μV/m on carrier 225 μV/m off carrier	3m	Certified
	70-130	1250-3750 on carrier 125-355 off carrier	3m	
	130-174	1250 on carrier 125 off carrier	3m	
	174-260	3750 on carrier 375 off carrier	3m	
	260-470	3750-12500 on carrier 350-1250 off carrier	3m	
	470 and above	12500 on carrier 1250 off carrier	3m	
	rf signal between 450 kHz and 30 MHz conducted into power network ' 250 volts			
o Device that measures the characteristics of a material (15.191)	any band provided requirements of sections 15.101 to 15.143 are satisfied			Certified
	13.554-13-566 MHz	15 μV/m on carrier .5 μV/m off carrier	3m	
	26.96-27.28	32 on carrier 1 off carrier	30m	
	40.66-40.70	50 on carrier 1.5 off carrier	30m	
	above 800	500 on carrier 50 off carrier (harmonic freq) 15 off carrier (other freq)	30m	
- Field Disturbance Sensors (15.305)	any band	15 μV/m	λ/2π	Certified 15.312
	915 ± 13 MHz	50,000 μV/m	30m	
	2450 ± 15 MHz	50,000 μV/m	30m	
	5800 ± 15 MHz	50,000 μV/m	30m	
	10525 ± 15 MHz	250,000 μV/m	30m	
	24125 ± 50 MHz	250,000 μV/m	30m	

*46FR55527 and 47FR51759

TABlE A-1

(Page 6 of 6)

Class of Device	Allowable Operating Band	Allowable Field Strength	Measurement Distance	Equipment Authorization Reqmt.
-Auditory Assistance Devices (15.331)	any band provided requirements in section 15.101-15.143 are satisfied			Currently None
	72-76 MHz	8000 µV/m (unmodulated carrier)	30m	Certified*
	narrowband	150 µV/m outside 50 kHz from carrier		
	wideband	150 µV/m outside 200 kHz from carrier		
	88-108	50 µV/m within 200 kHz band 40 µV/m outside 200 kHz band		
-Computing Device (15.801) Class A Device	30-88 MHz	30 µV/m	30m	Verified
	88-216 MHz	50 µV/m	30m	
	216-1000 MHz	70 µV/m	30m	
	rf signal between .45-1.6 MHz and 1.6-30 MHz conducted into power network shall be less than 1000 µ volts and 3000 µ volts respectively.			
Class B Device	30-88 MHz	100 µV/m	3m	Certified
	88-216 MHz	150 µV/m	3m	
	216-1000 MHz	200 µV/m	3m	
	rf signal between .450-30 MHz shall not exceed 250 µvolts			
-TV Interface Devices (15.601)	30-80 MHz	100 µV/m	3m	Certified
	80-216 MHz	150 µV/m	3m	
	216-1000 MHz	200 µV/m	3m	

APPENDIX B

OPERATING RESTRICTIONS FOR UNLICENSED ELECTRONIC DEVICES - GOVERNMENT

TABLE B-1

(Page 1 of 4)

OPERATING RESTRICTIONS FOR
UNLICENSED ELECTRONIC DEVICES - GOVERNMENT
(TAKEN FROM NTIA MANUAL -
SPECIFIC SECTIONS ARE REFERENCED)

Class of Device	Allowable Operating Band	Allowable Field Strength	Measurement Distance
√Incidental Radiation Device (7.8)	------- no specific restrictions specified but must not cause harmful interference		
√Restricted Radiation Device (7.9)	all bands	15 µV/m	157,000/f(kHz) ft
√-low power communications device (7.9.2)	10-490 kHz	240-5 µV/m*	1000 ft
	510-1600	47-15 µV/m*	100 ft
	160-190	rf power input to final stage ≤ 1 watt	
	510-1600	rf power input to final stage ≤ 100m watt	
		rf signal between 510-1600 kHz input to power network ≤ 200 µvolts	
√o Operation in 26.97-27.27 MHz band (to be operated until 18/Sept/83)	26.970-27.270 MHz	rf input to final stage ≤ 100 m watts	

√indicates corresponding provisions are included in FCC rules.
* linear interference

TABLE B-1

(Page 2 of 4)

Class of Device	Allowable Operating Band	Allowable Field Strength	Measurement Distance
√o Non-voice device	26.97-27.26 six channels	10,000 μV/m on carrier	10 ft
	20 kHz wide	500 μV/m outside 10 kHz from carrier	10
		rf signal below 25 MHz conducted into power network ≤ 100 mw	
o Wireless microphone	29.89-38 MHz, 38.25-42	mean output power ≤ 100 milliwatts	
√o Operatons in 49.82-49.90 MHz	49.82-49.90 MHz	10,000 μV/m on carrier	10 ft
	four channels 20kHz wide	500 μV/m outside 10 kHz from carrier	10
		rf signal below 25 MHz conducted into power network ≤ 100 volts	
√o Operations above 70 MHz (not to be used on door openers)	70-130 MHz	50 μV/m	100 ft
	130-174	50-150*	100
	174-260	150	100
	260-470	150-500*	100
	above 470	500	100

*linear interpolation

TABLE B-1

(Page 3 of 4)

Class of Device	Allowable Operating Band	Allowable Field Strength	Measurement Distance
√o Operations in 88-108 MHz band wireless microphone and telemetry	88-108 MHz 200 kHz wide channels	50 μV/m within 200 kHz channel	50 ft
		40 μV/m outside 200 kHz channel	10
√o Device that measures material characteristics	13.554-13.556 MHz	15 μV/m on carrier .5 off carrier	100 ft
	26.96-27.27	32 on carrier 1. off carrier	100
	40.66-40.70	50 on carrier 1.5 off carrier	100
	902-928 2400-2500 5725-5875 24000-24250	500 on carrier 50 off carrier 15 spurious signal	100
√o Biomedical Telemetry Device	38-41 MHz	10 μV/m within 200 kHz channel	50 ft
		10 μV/m outside 200 kHz channel	10
	174-216	150 μV/m within 200 kHz channel	100
		15 μV/m outside 200 kHz channel	100
o Radiodetermination device	915 ± 13 MHz	Effective radiated power < 10 watts	

TABLE B-1

(Page 4 of 4)

Class of Device	Allowable Operating Band	Allowable Field Strength	Measurement Distance
√o Radio Controlled Door Openers (15.184)	70-130 MHz	125-375* μV/m	30m
	130-174	125	30
	174-260	375	30
	260-470	375-1250*	30
	above 470	1250	30
√ -Field-Disturbance Sensor (7.9.1)	any band	15 μV/m	$\lambda/2\pi$
o Narrowband	915 ± 13 MHz	50,000 μV/m	100 ft
	2450 ± 15	50,000 μV/m	100
	5800 ± 15	50,000 μV/m	100
	10525 ± 25	250,000 μV/m	100
	24125 ± 50	250,000 μV/m	100
o Wideband	1.7-2.3 MHz	100 μV/m	100
	4.05-4.95		
	7.4-9.0		

*linear interpolation

APPENDIX C

SECTION 302 OF THE COMMUNICATIONS ACT OF 1934 AS REVISED BY PUBLIC LAW 97-257

APPENDIX C

Section 302 of the Communications Act of 1934
as revised by Public Law 97-257

Section 302: (a) The Commission may, consistent with the public interest, convenience, and necessity, make reasonable regulations (1) governing the interference potential of devices which in their operation are capable of emitting radio frequency energy by radiation, conduction, or other means in sufficient degree to cause harmful interference to radio communication; and (2) establishing minimum performance standards for home electronic equipment and systems to reduce their susceptibility to interference from radio frequency energy. Such regulations shall be applicable to the manufacture, import, sale, offer for sale, ~~shipment, or use of such devices~~ or shipment of such devices and home electronic equipment and systems, and to the use of such devices.

(b) No person shall manufacture, import, sell, offer for sale, ~~ship, or use devices~~ or ship devices or home electronic equipment and systems, or use devices which fail to comply with regulations promulgated pursuant to this section.

(c) The provisions of this section shall not be applicable to carriers transporting such devices or home electronic equipment and systems without trading in them, to devices or home electronic equipment and systems manufactured soley for export, to the manufacture, assembly, or installation of devices or home electronic equipment and systems for its own use by a public utility engaged in providing electronic service, or to devices or home electronic equipment or systems for use by the Government of the United States or any agency thereof. Devices or home electronic equipment and systems for use by the Government of the United States or any agency thereof shall be developed, procured or otherwise acquired, including offshore procurement, under United States Government criteria, standards, or specifications designed to achieve the ~~common objective~~ objectives of reducing interference to radio reception and to home electronic equipment and systems taking into account the unique needs of national defense and security.

APPENDIX D

FREQUENCY MANAGEMENT ADVISORY COUNCIL REPORT ON CONSUMER ELECTRONIC DEVICES (FMAC 36A-83)

APPENDIX D

Frequency Management Advisory Council

Coordination to Enhance Interference Rejection
of Consumer Electronic Devices

A. Introduction

The NTIA has asked the FMAC to examine alternative approaches for enabling industry to efficiently obtain a description of the authorized Government signals that are likely to interfere with consumer electronic devices under design.

B. Problem

The consumer eletronics market continues to expand in size and scope. The variety of devices available extends from inexpensive toys to sophisticated business and entertainment systems. For example, there are model airplanes, garage door openers, computers, security alarms, electronic organs, public address systems, medical alert devices and many more. The keen competition and diverse sources in this market have worked to the consumer's benefit in many respects, but do create the opportunity for problems, immediate or potential, due to radio interference from authorized radiations by the Government radio services.

C. Regulatory Provisions

For many years the FCC Rules on restricted and incidental radiation devices have made it clear that in the operation of such devices interference must be accepted that may be caused by authorized radio services ("sufferance rule"). The degree of attention to this has been at the discretion of the manufactures and users, but that was as far as the Commission could go under the Communications Act of 1934.

While such formal provisions would appear to give clear precedence to authorized radio services when interference is actually encountered, in practice the effect is not that straightforward.

For one thing, the proviso relates to "users", the public, which is ill-prepared to cope with such problems, and any effort at cooperation at that level by the authorized spectrum user may entail large numbers of individual cases.

Furthermore, the interference susceptibility of a particular device may only become apparent after a particular Government station or service is implemented; if, by the time, quantities of the device have already come into use and have been giving satisfactory performance for some period of time, the public will see the Government station as the "offender" and this may well create public or political pressure for the Government station to give way in spite of the sufferance rule.

In an effort to improve on this situation, some of the FCC Rules have, of late, encouraged manufacturers to consider the susceptibility of their systems and they have been specifically invited to obtain information on Government operations from NTIA.

D. Communications Amendments Act of 1982

The first legal step toward potential control of susceptibility to interference was taken in the 1982 Act. It gives the FCC Rules, to provide information on Government operations to manufacturers, on request, for the purpose of reducing the susceptibility of equipment to authorized Government stations. There has been response from industry, although limited in numbers so far, and it has been acknowledged that in most cases the information has been helpful.

While that is no evidence as yet as to specific effects on design - or particular cases of potential interference avoided - it is felt that such a program shows promise and is worthy of expansion. A strong effort should be made in this direction in order to see just how fully the problem can be met in this way.

Alternatives such as voluntary industry standards seem unlikely in this diverse and highly competivie field. Similarly, an effort to genuinely familiarize the public with the potential problem through a public information program, or even through equipment labels, seems unlikely to be effective (although labels, might provide a certain degree of formal protection in handling instances of interference).

This is not to say that consideration of such alternate steps should be dropped completely. Should an opportunity develop for effective public information - or should the FCC undertake to establish standards for the susceptibility of home devices - the NTIA should exploit these opportunities. But, for now it seems clear that the emphasis must be on reaching the designers at an early stage and in a cooperative manner.

F. NTIA Information Program

The FMAC believes that the current approach, wherein NTIA responds to information requests from industry, is a good start and the information currently supplied appears, based on a small sample, to be consistent with the needs of those who are reached.

G. Recommendations

The FMAC recommends that:

1. The NTIA information program be continued, but with increased effort to broaden the effectiveness. At the same time, in order to avoid setting precendents based soley on current usage, it will be improtant to include an indication of the dynamic aspects of government spectrum usage and the possibility that current guidance is subject to future changes. The mention in the FCC Rules as to the availability of information, which appears to be the augmented by a focused NTIA effort to publicize that matter more widely. Preferably this would be paralledled by increased activity on the part of the FCC, with the two efforts well coordinated.

   Direct contact by government people with principal industry associations would be an important step in this direction. Participation in appropriate technical meetings, and conventions or

professional and trade correspondance with likely manufacturers might be undertaken, based on a review of news items in the popular and trade press, and on timely review of news items on a patent actions.

2. The field experience of Government users with interference cases be methodically collected at a central point and analyzed for types of devices, or even particular manufacturers, requiring close attention. This would insure that the Government is kept informed as to areas of development requiring priority attention. Related to this might be the offering of consultation to Government users encountering field problems, to enhance the feedback process.

In conclusion, the FMAC applauds the realistic attention being given to this matter by NTIA and feels that an expanded program, as recommeded above, would be in the interest of the Government, as a user of the spectrum, and of the public in general.

FORM NTIA-29
(4-80)

U.S. DEPARTMENT OF COMMERCE
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15. ABSTRACT *(A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)*

Increases in user demand for, and the availability of, new electronic products that don't require an individual operating license or frequency assignment have resulted in diverse use of the radio frequency spectrum in disparate operating environments. Some of these electronic devices have an impact on authorized Government telecommunications. The scope of identified problems, the recent revision of regulatory authority in this area, and the potential shown by recent technological advances requiring additional unlicensed spectrum demonstrate that relevant federal policy and its implementation require review.

This document, a spectrum resource assessment, addresses representative problems and policies regarding unlicensed electronic devices and presents approaches aimed at avoiding future problems associated with unlicensed devices.

(abstract continued on page 2)

16. Key Words *(Alphabetical order, separated by semicolons)*

Government Radio Services; Home Electronic Equipment and Systems; Incidental and Restricted Radiation Devices; Radio Frequency Devices; Radio Frequency Spectrum Management; Minimum Performance Standards; Unlicensed Receivers

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Primary recommendations include: (1) the establishment of centralized reporting system for interference related to unlicensed devices, (2) continued dialogue with the FCC and private industry, (3) review of future FCC actions related to unlicensed devices, and (4) the provision that NTIA, upon request, provide typical Government equipment characteristics to private industry.