FCC AND ELECTRICAL INTERFERENCE

INTRODUCTION

The Federal Communications Commission has been controlling the generation of electrical interference which interfered with communications, for many years. As communications equipment became more complex and utilized larger segments of the spectrum, and the spectrum became more crowded with radiation from electronic, industrial, commercial and consumer equipment, the FCC has increased the scope and effectiveness of its regulations. On October 1, 1970, the rules requiring manufacturers, vendors, and shippers of electronic devices to meet FCC electromagnetic interference regulations have become effective.

The new rules implemented a 1968 law empowering the FCC to make reasonable regulations governing the interference potential of certain devices. The purpose of the new rules is to require compliance with equipment standards by manufacturers, importers and distributors of RF devices, as well as by users.

RF devices subject to FCC authority and included under the amended rules range from the many kinds of radio transmitters used in the broadcasting, common carrier, marine, aviation and land mobile services to restricted radiation devices such as radio receivers, CATV systems, and low power communication devices such as wireless microphones, phonograph oscillators, radio controlled garage door openers, radio controlled models and toys. Also included are industrial, scientific and medical equipment such as ultrasonic industrial heating, medical diathermy, radio frequency stabilized arc welders and miscellaneous equipment.

Exempted from the 1968 law are carriers transporting radio frequency devices but not trading in them, devices manufactured solely for export, and devices to be used by the U.S. Government.

At the time of this publication, a number of rule makings are pending, but it cannot be anticipated when the final rules will be adopted. Thus, attention is called to the following rule-making proceedings:

DOCKET NO. 19183: Inquiry into performance of television broadcast receivers and location of FM transmitters to alleviate interference to television reception. Adopted: March 24, 1971

DOCKET NO. 19185: Amendment of the Commission's Rules and Regulations to provide for the licensing of auditory training devices for the partially deaf in the bands 72-73 and 75.4-76 MHz. Adopted: March 24, 1971

DOCKET NO. 19231: Amendment of Part 15 of the Commission's Rules to exclude from the duty cycle requirement biomedical radio telemetry systems operating above 70 MHz. Adopted: May 19, 1971

DOCKET NO. 19268: Comparable Television Tuning Regulation. Adopted: June 24, 1971

DOCKET NO. 19281: Amendment of Part 15 of the Commission's Rules to regulate the operation of a Class I TV device–a new restricted radiation device which produces an RF carrier modulated by a TV signal, and Amendment of Part 1 to provide a fee schedule for type approval of such devices. Adopted: September 8, 1971

DOCKET NO. 19092: Carrier-Current Radio Systems Operating Pursuant to Section 15.7 of the Commission's Rules and Low Power Communications Devices Operating Pursuant to Subpart E of Part 15 of the Commission's Rules. Adopted: March 24, 1971

The following information consists of bulletins (condensed) issued by the FCC to help industry to understand the regulations.

RECEIVER CERTIFICATION REQUIREMENTS

(BULLETIN OCE 24
July 1971)

Receiver certification was initiated on February 1, 1956, as a result of rules promulgated by the Commission on December 21, 1955. Originally voluntary on the part of the manufacturer, certification was made mandatory on October 1, 1970. At about the same time, on August 1, 1970, the Commission put into effect a program requiring the payment of a fee for each receiver model that is certificated.. The fee is in two parts: a FILING FEE that must accompany the application and a GRANT FEE due after the receiver has been certificated.

The receiver certification program applies to all receivers that operate in the range 30-890 MHz. Each model must be separately certificated. Certification is granted contingent on the payment of the required grant fee.

What Is A Model: A receiver model is an assembly of components designed to achieve a specific reception function, and identified by a distinctive model number. If a change is made in the circuitry so that the characteristics required to be measured and reported to the Commission are changed, the new assembly is considered a different model and a new model number must be assigned.

The model number for which certification is requested must be identical to the model number that will be inscribed on the receiver. There is no objection ot the use of a model numbering system which includes in the model number, digits or letters to indicate marketing or production information, such as color of the cabinet; however, each such model is considered a separate receiver model which requires individual model certification and filing and grant fees.

If two identical receiver models will be distributed under different model numbers or under different trade names regardless of whether the same number is used) they are two separate receiver models and require separate model certifications and filing and grant fees.

Multiband Receivers: *FM and TV:* Administratively, it has been decided to count a combination FM-TV (with or without other bands) broadcast receiver as two receiver models.

FM and Other: A combination of FM with any other band such as police or aeronautical, but not including TV, is considered as one receiver model requiring a filing fee.

Other Combinations: Other combinations bearing a single model number, such as a receiver combining an aeronautical band and a police band, will also be considered as a single receiver model requiring a filing fee.

Transceivers: For such combinations, an application must be filed for certification of the receiver part of the equipment, and an application must be filed for type acceptance of the transmitter part of the equipment. These applications should be suubmitted simultaneously but under separate cover to facilitate handling.

Receiver Certificated prior to August 1, 1970: A receiver model which was certificated prior to August 1, 1970, and which will continue to be distributed after August 1, 1970, under the same trade name, the same model number and with identical circuitry need not be recertificated and no filing or grant fee is required for such continued distribution.

However, if a receiver model certificated prior to August 1, 1970, will be distributed after August 1, 1970, under a different trade name or model number, it will be considered a new receiver model and a new application for certification and filing fee must be submitted. Such an application, where there is no change in circuitry, does not require a new set of measurements.

Incomplete Information: An application for receiver certification must contain all the information required by Subpart C of Part 15. Attention is called to several items that are frequently found incomplete: description of measurement procedure, report of measurements, description of measurement facilities.

Measurement Procedure: The measurement procedure used by the applicant must be acceptable to the Commission. For the measurement of oscillator radiation from Fm and TV receivers, three procedures have been found acceptable and are listed in 15.75:

IEEE 187
IEC 106 and 106A
EIA RS-378

If one of these procedures is used, the application should so state. If any other procedure is used, it should be described in detail, so that a determination of acceptability can be made. With slight modifications, the above listed procedures can be used to measure radiation from other types of receivers. In such cases, it will be sufficient to indicate what procedure was used and the modifications that were made.

Report of Measurements: *Fixed Frequency Receivers:* The report must show that the spectrum was investigated from 0.45 to 1000 MHz and all significant emissions should be reported. Emissions more than 20 dB below the levels specified in 15.63 need not be reported.

Tunable Receivers: For FM receivers, measurements should be made with the receiver tuned to at least three points: one each at the top, the middle and the bottom end of the tuning range. For each point measurements should be made covering the range 0.45 to 1000 MHz and all significant emissions should be reported. Emissions more than 20 dB below the levels specified in 15.63 need not te reported.

For TV receivers, measurements should be made of the oscillator frequency for each VHF channel and of the UHF oscillator frequencies. The report should indicate that the spectrum was scanned for harmonics of the oscillator in each case and should report those harmonics which are within 20 dB of the levels specified. The report should also include conducted measurements over the range 0.45 to 25 MHz when required.

For other tunable receivers, make measurements with the receiver tuned to each of three points: top, middle and bottom of the tuning dial. At each point measurements should be made over the range 0.45 to 1000 MHz and each significant emission should be reported.

Measurement Facilities: A description must be filed of the measurement facilities used to measure receivers for certification. To facilitate handling, this description should be submitted as a separate document and should include the following information:

- –Location of the site
- –physical description of the site, preferably supported by photographs
- –description of supporting structures used in the measurement
- –list of measuring equipment used
- –information concerning the calibration of the measuring equipment

This description should be supplemented every time there is a change in the information supplied to the Commission.

DOES MY TRANSMITTER NEED A LICENSE?

(OCE BULLETIN 11
January 1969)

"Do I need a license for this transmitter? It uses so little power." The answer depends on many conditions. This bulletin explains when a license is required and when a transmitter may be operated without a license.

Electromagnetic Compatibility: When a radio transmitter is operated, RF energy is emitted into the surrounding space. This energy may cause interference. To avoid causing interference, the equipment must be carefully designed, the frequency must be carefully selected, and the transmitter must be operated under suitable safeguards. The condition under which a generator of RF energy - be it transmitter or other device - can operate in the vicinity of other radio equipment without upsetting or interfering with the radio operations of its neighbors is called *Electromagnetic Compatibility*.

Wireless Microphone: A wireless microphone is a low power communication device that contains a microphone (an electro-acoustic transducer for converting sound waves into corresponding electric current or voltage variations), a transmitter modulated by the microphone, and a radiating element. The modulated output of the wireless microphone is fed into its associated amplifier by electromagnetic radiation instead of wires.

A magnetic pick-up or the pick-up on a record player is not considered to be a microphone.

Telemetering Transmitters: Another use for low power transmitters is in telemetering. This is a form of communication in which information collected by various sensing devices is transmitted to a nearby receiver-recorder. Telemetering transmitters are generally used in places where it is impossible or very costly to connect the sensing device to the recorder by cable or where the connecting wires would constitute a hazard. In industry, for example, telemetering transmitters have been used to record the readings of strain gauges attached to the rotors of large machines. In medical research, they have been used to record physiological data-heart action, blood pressure, respiratory rate, body temperature–of human and animal subjects while in motion.

Radio Controls for Garage Door Openers: One way of opening a garage door without getting out of the automobile is to use a radio control activated motor to open the door. The transmitter, in the car, is designed to emit a short RF pulse which is coded with one or more tones. Coding is used to provide a degree of security and to minimize interference to other controls in the vicinity.

(a) Licensed Use: The transmitter may be licensed as a Class C Citizens Radio Station for operation on specified frequencies in the 27 Mc/s band. Ask for SS Bulletin No. 1001 for details of such operation.

(b) Nonlicensed Use: The radio control for a garage door opener may be operated without a license pursuant to the provisions of Subpart E of Part 15. See 15.201 through 15.238. If the radio control operates above 70 Mc/s, no radiation, either from the transmitter or receiver part of the control, may fall in the prohibited frequency bands listed in 15.211. Just as with other devices operated pursuant to Part 15, if the radio control causes harmful interference, its operation must be stopped and may not be resumed until the harmful interference has been eliminated (15.3, 15.4, 15.222).

Receivers Associated with Miniature Transmitter: In addition to interference which may be caused by transmitters, interference may also result from receiver oscillator radiation. Harmful interference from radio receivers is just as real and just as damaging as harmful interference from transmitters. Receivers associated with miniature transmitters must also comply with FCC Rules (Subpart C, Part 15). If the receiver operates in the range 30-890 Mc/s, it must bear a seal certifying that it complies with the FCC Rules.

OPERATION IN THE BAND 535-1600 kHz WITHOUT AN INDIVIDUAL LICENSE

(OCE 12
September 1970)

Introduction

The band 535-1600 kHz is allocated for broadcast stations. However, under the provisions of Part 15 of the Commission's Rules, a *Low Power Communication Device* or a *Carrier Current System* may be operated in this band without an individual license on the condition that

- No harmful interference is caused to licensed operations, and
- The technical and other requirements of Part 15 are met.

Harmful Interference

Harmful interference is defined by the Commission as any emission, radiation, or induction which endangers a radionavigation or a safety service, or which seriously degrades, obstructs, or repeatedly interrupts other licensed radio services. Since this discussion deals with operation in the AM band (535-1600 kHz), the operator must take particular care to protect the broadcast service.

Due to the physical laws of radio propagation on frequencies in the AM band, operation with low power and a small antenna is inherently short range. Thus it is possible to set up operating conditions in the AM band that will protect the broadcast service and still provide a reasonable operating range for the owner of a low power communication device.

This cannot be done in the FM band (88-108 MHz). Conditions in this band are completely different and long range transmission is possible even with extremely low power–a fact that is well known and well documented. In the face of this physical phenomenon, the Commission has not found it possible to set up operating conditions on the FM band that would provide a reasonable operating range. Accordingly operation in the FM band is strictly prohibited.

See Information Bulletin No. 17-G for a more detailed discussion of the interference problem. For a discussion of radio wave propagation and transmission range of radio signals, the reader should refer to text books on the subject of radio available in libraries. Index search under the term radio wave propagation should lead to desired information.

Low Power Communication Device

Part 15 permits two types of operation in the AM band. One type uses radiation of radio waves; the other uses carrier current techniques.

To emit radio waves, a miniature transmitter called a LOW POWER COMMUNICATION DEVICE is connected to a small antenna. Part 15 imposes a limit of 100 milliwatts on the power input. The antenna must not be longer than 10 feet which includes the length of the antenna proper *plus* the length of the transmission line *plus* the length of the ground lead, if used. The rules also require that any RF energy emitted by the device on frequencies below 50 kHz or above 1600 kHz be suppressed at least 20 dB below the unmodulated carrier. Finally, the rules impose a special requirement on transmitters that get their power from the regular AC power. This special requirement is that the RF energy fed back into the power lines must not be greater than 200 microvolts when measured from either line to ground with the transmitter grounded and also when it is not grounded. Operation without regard to power or antenna length is also possible provided such operation does not exceed the field strength determined by the formula in 15.202.

However whichever set of technical specifications is used, *the operator may not cause harmful interference and must immediately stop operating when notified that he is causing harmful interference.*

The technical specifications imposed by Part 15 are purposely designed to limit the coverage that may be obtained in order to protect the broadcast service. Consequently one should not expect to obtain radio coverage beyond about 300 feet. In fact, coverage beyond 300 feet is usually an indication that the operation does not conform to these limits and violates the Part 15 Rules. Requests for permission to operate outside these limits will not be granted. Relaxing these technical limits to permit extended coverage, greatly increases the interference potential to the broadcast service and cannot be permitted.

The operator of a low power communication device is urged to read the Part 15 regulations appended to this bulletin. Attention is particularly invited to the requirement for certification in 15.227 and 15.228.

Frequencies

The FCC does not designate the specific frequency to be used by a low power communication device. The operator of the device may select his own frequency in the band 535-1600 kHz. The operator must make sure however, that his selection of an operating frequency will not cause harmful interference to persons trying to receive broadcast signals.

FCC TEST PROCEDURE FOR WIRELESS MICROPHONES AND TELEMETERING DEVICES SUBMITTED FOR TYPE APPROVAL UNDER PART 15

(BULLETIN OCE 19
January 1969)

Introduction

This Bulletin is intended as a guide to manufacturers and others who are required to make measurements on wireless microphones pursuant to 15.235(a)(1) for the purpose of obtaining Commission type approval. It explains the basic tests used by the Commission and points out several factors that have been found to influence the output of these devices and which may cause operations inconsistent with the technical requirements of Part 15.

Characteristics to be Measured.

Measurements are made of the tuning range, emission bandwidth, and the radiation from the equipment on the fundamental frequency, its harmonics, and any spurious frequencies (including the operating frequency and harmonics of the oscillator, if on a frequency different from the fundamental frequency.)

Measurement Procedure for Wireless Microphone.

Tuning range

The tuning adjustments on the equipment are set to the positions giving the highest and lowest frequencies of oscillation and the frequencies are then measured with a suitable frequency meter. The frequency must remain within the range 88 Mc/s plus half of the observed bandwidth to 108 Mc/s less half of the observed bandwidth. For a unit with the maximum permissible bandwidth, the corresponding limits are 88.1 and 107.9 Mc/s.

Emission bandwidth.

Measurement of emission bandwidth is made using a spectrum analyzer and associated receiver tuned to the operating frequency of the equipment. If the particular unit has an AF volume control (internal or external) the tests are made with this set to maximum, unless the control is sealed with epoxy or other permanent cement. These measurements must be made with a suitable audio input into the microphone. In most measurements to date, the greatest bandwidth has been produced by words such as "more", "poor", containing the long "o" or "oo" vowels. Some units, however, have produced the greatest bandwidth with words such as "five", containing the long "i" vowel.

Radiated energy.

Measuring site. The measuring site shall be an open field appreciably free of interfering signals. A level, sod surface; free of trees and shrubs has generally been found best. The area should be free of reflecting structures and surfaces within a circle having a diameter of 100 feet.

Instrumentation. A standard field strength meter shall be used. The FSM shall be provided with a calibrated dipole antenna capable of being adjusted for horizontal and vertical polarization and varied in height from 2 to 20 feet.

Test set-up. The wireless microphone is placed on a wooden support 4 feet high preferably mounted on a turntable. The measuring antenna is set up at a distance of 50 feet for the fundamental or 10 feet for all other frequencies (harmonics and other spurious).

Procedure. Measurements shall be made all around the wireless microphone. Preferably, this shall be accomplished by setting the wireless microphone and its supporting structure on a turntable. If a turntable is not used, the device shall be manually oriented for maximum value of field strength.

The spectrum should be investigated from the lowest frequency generated in the device up to 1000 Mc/s.

If the microphone is connected to the transmitter part of the device by a cable, measurements shall be made with the specific microphone and cable that will be used with the device since the length of connecting cable affects the radiation from the device. The orientation and relative layout of the microphone and transmitter parts of the device shall be varied to determine the effect on the radiated field. The highest value of field observed under these variations shall be recorded.

The report shall state the specific microphone and the exact length of microphone cable used.

Measurement Procedure for Telemetering Device

Tuning range.

The tuning adjustments on the equipment are set to the positions giving the highest and lowest frequencies of oscillation and the frequencies are then measured with a suitable frequency meter. The frequency must remain within the range 88 Mc/s plus half of the observed bandwidth to 108 Mc/s less half of the observed bandwidth. For a unit with the maximum permissible bandwidth, the corresponding limits are 88.1 and 107.9 Mc/s.

Emission bandwidth.

Measurement of emission bandwidth is made using a spectrum analyzer and associated receiver tuned to the operating frequency of the device. If the device has a level control (internal or external) the measurement is made with the control set for maximum output, unless the control is sealed with epoxy or other permanent cement.

Tests should be conducted with all the sensing devices or transducers that will be connected to the telemetering transmitter. The input that will be used during normal operation should be applied for the tests. Devices designed to telemeter physiologic functions should be tested while attached to the body as in actual use.

Radiated energy.

Measuring site. The measuring site shall be an open field appreciably free of interfering signals. A level, sod surface, free of trees and shrubs has generally been found best. The area should be free of reflecting structures and surfaces within a circle having a diameter of 100 feet.

Instrumentation. A standard field strength meter shall be used. The FSM shall be provided with a calibrated dipole antenna capable of being adjusted for horizontal and vertical polarization and varied in height from 2 to 20 feet.

Test set-up. The test set-up should simulate as much as possible the actual operating conditions. Tests should be conducted with all the sensing devices or transducers that will be used. The measuring antenna is set up at a distance of 50 feet for the fundamental or at 10 feet for all other frequencies (harmonics and other spurious).

Procedure. Measurements shall be made all around the telemetering device. If a turntable is not used, at least 8 measurements shall be taken essentially equispaced around the device or the device may be repeatedly shifted in position to achieve the equivalent result in lieu of moving the field strength meter. At each point the measuring antenna shall be varied in height and polarization. The orientation and relative layout of the telemetering device and its sensors shall be varied to determine the effect on the radiated field. The highest value of field observed under these variations shall be recorded.

Pulsed Emissions.

There is no objection to the use of pulsed emission for telemetering operations in the band 88-108 Mc/s, provided the restrictions on bandwidth and emitted field strength are observed.

Field Strength of Pulsed Emissions. For the purpose of determining compliance with 15.212, the field strength of pulsed emissions should be averaged over a period of 0.1 second.

Bandwidth of Pulsed Emissions. Care must be taken to properly shape the pulse so that the emitted signal does not occupy a bandwidth, as indicated on a spectrum analyzer, in excess of 200 kc/s centered on the operating frequency.

ATTACHMENTS TO TYPE APPROVED EQUIPMENT ILLEGAL

(Bulletin OCE 10
April 1965)

Owners and operators of equipment type approved under Parts 15 or 18 are cautioned against using such equipment with auxiliary devices that are not covered by the type approval.

Before attaching such auxiliary devices, the user should assure himself that the combination was tested and found to comply with the FCC regulations. Examples of such auxiliary devices that may NOT be attached without prior approval:

- a low voltage stimulator to a type approved medical diathermy or ultrasonic equipment.
- a different tank to a type approved ultrasonic cleaner.
- a microphone on an extension cable to the transmitter part of a type approved wireless microphone.

Experience has shown that the connection of additional cables changes the radiating characteristics of radio frequency generating equipment. In general, the connection of such additional cables can be expected to increase the radiation since these cables tend to act as radiating antennas. Tests at the Commission's Laboratory have definitely established that in many instances, the connection of a second piece of equipment to a piece of type approved equipment will increase the radiation of radio frequency energy from the type approved equipment. The operation of type approved equipment with increased radiation is a violation of Part 18 of the Commission's Rules and is illegal. Furthermore, such operation invalidates the certificate of type approval.

Accordingly, before any auxiliary equipment is connected to a type approved piece of medical equipment for simultaneous treatment of a patient with two forms of therapy, the combination must be tested to establish that the type approved equipment will continue to comply with FCC regulations.

Similarly, before an extension cable is used with a type approved wireless microphone, or before two or three microphones are connected through a mixer to a type approved wireless microphone, the combination must be tested to establish that the type approved wireless microphone will continue to comply with FCC requirements.

FCC TEST PROCEDURE FOR MICROWAVE OVENS SUBMITTED FOR TYPE APPROVAL UNDER PART 18

(BULLETIN OCE 20
March 1970)

Introduction

This Bulletin is intended to assist manufacturers and others who find it necessary to make measurements on microwave ovens intended for type approval under Part 18 of the Commission's Rules. It explains the test procedures presently used by the Commission's Laboratory and points out several factors which have been found to influence the ability of these devices to comply with the requirements of Part 18. For the purpose of this Bulletin, equipment operating on frequencies as low as the ISM band at 915 MHz is considered to be "microwave."

Characteristics of Typical Equipments.

All ovens which have so far been tested for type approval employ magnetrons for generating the power which they use. Typically, a magnetron will generate power on its fundamental frequency, and to a lesser extent on harmonic and spurious frequencies not harmonically related to the fundamental frequency. These latter may be either below or above the fundamental frequency. If the power supply to the magnetron is self-rectified, or is rectified and poorly filtered, there will also be a series of AM and FM sidebands of appreciable intensity on either side of the fundamental frequency. Almost all ovens have a "stirrer" provided to shift the standing wave pattern in the work space so as to produce more even heating of the work load. One make shifts the position of the load to produce the same effect. This device produces cyclical shifts in the frequency of the magnetron, and other effects due to the changes in loading which it causes. It is practicable to apply sufficient shielding around the magnetron package to a low level. If the oven cavity is provided with a good door seal, and all ventilating openings and accessory connections are properly screened, the leakage from the oven itself can be reduced. The importance of proper door seal design can hardly be overemphasized, particularly with regard to service life of this seal.

Characteristics to be Measured.

Measurements are made of the operating frequency, the maximum power delivered to a load, and the strength of the radiations on the fundamental frequency and all harmonic and spurious frequencies up to at least 10 GHz.

Load.

For all measurements the energy developed by the oven is absorbed by a dummy load, which consists of a quantity of tap water in a plastic or pyrex container. The size and shape of the container, its position in the oven, and the quantity of water are varied as required to produce the greatest frequency variation, the maximum power output, or the greatest indication of out-of-band radiation, depending upon the characteristic being investigated.

Measurement of Frequency.

Frequency measurements are made by beating a transfer oscillator against the fundamental frequency of the oven and measuring the frequency of the transfer oscillator with a suitable frequency counter. Counters cannot usually be employed for direct frequency measurement because of the effects due to modulation. Measurements will be made of:

a. Variation of frequency with load as described in 4.0.
b. Variation of frequency with time at constant load from a cold start.
c. Variation of frequency for line voltage variation from 80% to 125% of nominal rated voltage.

Measurement of Maximum Power Output.

The power output is measured at nominal rated voltage by the calorimetric method, from the observed temperature rise of a known quantity of water over a period of time, as converted to watts output. The process is repeated, using several different quantities of water, until the maximum power output is determined. The power input to the magnetron may also be measured to determine that the oven is operating in accordance with the manufacturer's specifications.

Measurement of Radiated Interference.

Test set-up

The oven is placed on a turntable at normal operating height. AC power is supplied via a flexible cable with the voltage adjusted to the nominal rate value. Measurements are made using the dummy load described in 4.0 in the oven.

Measuring equipment.

Measurements are made with standard field strength meters using dipoles on frequencies below 1 GHz and horns above 1 GHz. At the FCC laboratory at the present time a POLARAD FIM is used in the range 1 to 10 GHz. For frequencies below 1 GHz, Stoddart NM-22, NM-30 and NM-52 or Empire Devices NF field strength meters are used.

7.2.1 Detector circuit. Measurements are made using the average (or F.I.) detector circuit in the field strength meter. The emission from a microwave oven is often a very complex wave resulting from amplitude and frequency modulation of the R.F. carrier. The emission bandwidth of various ovens has been found to range from a fraction to several times the bandwidth (3 to 5 MHz) of usual microwave field strength meters. The average detector is used because it is the considered opinion of the Commission's experts that in view of the services likely to be interfered with by a microwave oven, average measurements will provide better correlation with the actual interference than peak or quasi-peak measurements.

Measurement procedure.

Initial measurements are made near the oven with the measuring antenna 10 feet from the nearest part of the oven. The oven is rotated about its vertical axis on the turntable, and the polarization and height of the receiving antenna are varied to obtain the highest field strength on the particular frequency under observation. The size and shape of the dummy load, and its position, are also varied to obtain the highest field. The 10-foot measurements are made in a large room or outdoors, with the equipment and antenna located so as to reduce effects due to reflections from the building or other items in the room. For 10-foot measurements, an antenna of small aperture (i.e., a small horn, without its reflector) is used. The field would be nonuniform over the area of a larger antenna, and such an antenna would therefore not have the gain normally expected.

The reading of the field strength meter is observed during the heating cycle as the following factors are varied:

a. oven orientation
b. load
c. antenna orientation
d. antenna polarization

The highest reading observed on the meter is recorded.

NOTE: The "stirrer" may cause the emitted energy to be scattered over a wide band of frequencies. It is recommended that the "stirrer" be stopped when measuring the maximum emission.

When measuring side bands close to the fundamental (just outside the tolerance limits of the ISM band) great care must be taken to avoid errors caused by overload from the fundamental frequency. A tunable filter can be usefully employed to reduce the level of the fundamental relative to the particular sideband if overload occurs. Overload can be detected by observing the relative change in signal level for different values of input attenuator, either internal or external to the FIM.

INDUSTRIAL RADIO FREQUENCY HEATERS REQUIRE PERIODIC INSPECTION

(OCE BULLETIN NO. 8
September 17, 1958)

Owners and operators of industrial radio frequency heaters are hereby notified that in addition to meeting the Commission's requirement for certification, these equipments must be inspected periodically. See Subpart F of Part 18–Industrial, Scientific and Medical Service (ISM Rules). These regulations, revised March 20, 1957, require that all industrial heating installations be inspected periodically in order to affirm the validity of the certificate attesting that the equipment complies with the Commission's requirements.

Qualifications of the Inspector

The inspector should be a person having training and experience in interference suppression. In addition, it is desirable that he be skilled in making and interpreting field strength measurements. Although the inspector should preferably be an engineer, an electrician or maintenance employee who has received special training in interference control and suppression techniques may be qualified to act as the inspector. The Commission may require the inspector to submit proof of his qualifications.

Inspection Procedure

The basic intent of the industrial heating regulations is to prevent interference. Certification of the heater gives reasonable assurance that the initial installation will not be a source of interference. The periodic inspection is intended to give assurance that this condition will continue. Accordingly, the periodic inspection should cover everything which, in the opinion of the inspector, is necessary to affirm the validity of the certificate. The frequency at which the inspection is made will depend on the inspector's knowledge of the operation and use of the heater, such as stability of the heater, the care given the heater by employees, whether the heater has been causing interference, and any other factors that may be applicable to a particular installation.

One inspection schedule that has been proposed, which the Commission believes will meet the intent of the rules for many installations, consists of two parts; one, physical inspection to be made every six months; and two, a radiation inspection to be made every three years for induction heating installations and every year for dielectric heating installations.

The following has been proposed in connection with the above: The physical inspection would include an examination of the machine and installation for modifications or changes, for good ground connections, clean contacts, cover plates in good condition, change in location, etc. The radiation inspection would include spot-checking the radiation from the equipment to determine whether there has been a change in the radiation characteristics of the equipment.

Log of Inspections

Each inspection of a heater must be logged and a log must be kept with the heater. The inspector's entry should clearly indicate the condition of the heater at the beginning of the inspection and what action was taken on the heater during the course of the inspection.

Recertification

If the inspector finds that recertification is required, then a new certificate must be prepared in the same manner as though it were a new installation. The certificate must comply with the requirements of section 18.104 of the Commission's Rules and Regulations.

EXTRACTS FROM PART 15 RF DEVICES

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 authorized radio service.

15.4 General definitions.

a. *Radio frequency energy.* Electromagnetic energy at any frequency in the radio spectrum between 10 kHz and 3,000,000 MHz.

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 radiocommunication 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.

e. . . . .

f. *Low power communication device.* A low power communication device is a restricted radiation device, exclusive of those employing conducted or guided radio frequency techniques, used for the transmission of signs, signals (including control signals), writing, images and sounds or intelligence of any nature by radiation of electromagnetic energy.

EXAMPLES: Wireless microphone, phonograph oscillator, radio controlled garage door opener and radio controlled models.

g.–h. . . . .

15.7 General requirement for restricted radiation devices.

Unless regulated under some other subpart of this part, any apparatus which generates a radio frequency electromagnetic field functionally utilizing a small part of such field in the operation of associated apparatus not physically connected thereto and at a distance not greater than

$$\frac{157{,}000}{F\,(\text{kHz})}\ \text{ft} \approx \frac{\lambda}{2\pi}$$

need not be licensed provided:

a. That such apparatus shall be operated with the minimum power possible to accomplish the desired purpose.

b. That the best engineering principles shall be utilized in the generation of radio frequency currents so as to guard against interference of established radio services, particularly on the fundamental and harmonic frequencies.

c. That in any event the total electromagnetic field produced at any point a distance of

$$\frac{157{,}000}{F\,(\text{kHz})}\ \text{ft}$$

from the apparatus shall not exceed 15 microvolts per meter.

d. & e. . . . .

15.11 Prohibition against eavesdropping

a. No person shall use either directly or indirectly, a device operated pursuant to the provisions of this part for the purpose of overhearing or recording the private conversations of others unless such use is authorized by all of the parties engaging in the conversation.

b. Paragraph (a) of this section shall not apply to operations of any law enforcement officers conducted under lawful authority.

SUBPART B–INCIDENTAL RADIATION DEVICES

15.31 Operating requirements.

An incidental radiation device shall be operated so that the radio frequency energy that is radiated does not cause harmful interference. In the event that harmful interference is caused, the operator of the device shall promptly take steps to eliminate the harmful interference.

SUBPART C – RADIO RECEIVERS

15.63 Radiation interference limits.

a. The radiation from all radio receivers that operate (tune) in the range 30 to 890 MHz, including frequency modulation broadcast receivers and television broadcast receivers, manufactured after the effective date specified in 15.72 shall not exceed the following field strength limits at a distance of 100 feet or more from the receiver:

Frequency of radiation (MHz)	Field strength (μV/m)
0.45 up to and including 25	See paragraph (b).
Over 25 up to and including 70	32.
Over 70 up to and including 130	50.
130-174	50-150 (linear interpolation).
174-260	150.
260-470	150-500 (linear interpolation).
470-1000	500 (see paragraph (c) below).

b. Pending the development of suitable measurement techniques for measuring the actual radiation in the band 0.45 to 25 MHz, the interference capabilities of a receiver in this band will be determined by the measurement of radio frequency voltage between each power line and ground at the power terminals of the receiver. This requirement applies only to radio receivers intended to be connected to power lines of public utility systems. For television broadcast receivers the voltage so measured shall not exceed 100 μV at any frequency between 450 kHz and 25 MHz inclusive. For all other receivers the voltage shall not exceed 100 μV at any frequency between 450 kHz and 9 MHz inclusive, 1000 μV for frequencies between 10 MHz and 25 MHz and linear increase from 100 μV to 1000 μV for frequencies between 9 MHz and 10 MHz.

c. For television broadcast receivers the limit in the band 470–1000 MHz shall be 350 μV/m, compliance being determined as follows:

1. Measurements shall be made at the following 10 frequencies in the band 470-1000 MHz.

MHz	MHz	MHz
520	700	850
550	750	900
600	800	931
650		

2. The average of the 10 measurements shall not exceed 350 μV/m.
3. No measurement shall exceed 750 μV/m.

15.68 All channel television broadcast reception: receivers manufactured on or after July 1, 1971.

a. *Effective date.* The requirements of this section, in addition to the requirements of 15.67, shall apply to 10 percent of the television receiver models produced by any domestic manufacturer, or exported to the United States by any foreign manufacturer, on or after July 1, 1971; 40 percent of the models produced (or exported to the United States) by any manufacturer on or after July 1, 1972; 70 percent of the models produced (or exported to the United States) by any manufacturer on or after July 1, 1973; and to all receivers manufactured (or exported to the United States) on or after July 1, 1974. They shall, in addition, apply to any receiver model manufactured (or exported to the United States) on or after January 1, 1972, and not manufactured prior to that date.

b. & c. . . . .

15.69 Certification of receivers.

a.1. & a.2. . . . .

a.3. No television broadcast receiver manufactured on or after July, 1, 1971, which has not been certificated to comply with the requirements of 15.68(b) shall be shipped in interstate commerce or imported from any foreign country, for sale or resale to the public, unless on the date of shipment, the manufacturer of that receiver is in compliance with the schedule set forth in 15.68(a). This provision does not apply to carriers which transport television broadcast receivers without trading in them.

b. – d. . . . .

e. The certificate shall contain the following information:

e.1. – e.9. . . . .

e.10. In the case of a television broadcast receiver designed to meet the requirements of 15.68, a description of the basic mechanism for tuning the VHF and UHF channels; a description of tuning aids provided for tuning VHF and UHF channels; at least two suitable 8" x 10" photographs, one showing the tuning controls on the outside of the cabinet, the other showing the tuning mechanism inside the cabinet; and a statement certifying that the receiver meets the requirements of 15.68.

f. . . . .

15.75 Measurement procedure.

a. Any measurement procedure acceptable to the Commission may be used to show compliance with the requirements of this subpart. A detailed description of the proposed measurement procedure, including a list of the test equipment to be used, shall be submitted to the Commission when requesting a determination regarding the acceptability of the proposed measurement procedure.

b. . . . .

15.80

c. In the case of measurements in the field, radiation in excess of 15 μV/m at any frequency between 450 kHz and 25 MHz at the border of the property and more than 15 feet from any power line crossing this border under the control and exclusive use of the person operating or authorizing the operation of the receiver will be considered an indication of noncompliance with the radiation requirements of this subpart.

SUBPART D–COMMUNITY ANTENNA TELEVISION SYSTEMS

15.161 Radiation from a community antenna television system.

Radiation from a community antenna television system shall be limited as follows:

Frequencies (MHz)	Distance (ft.)	Radiation limits (uV/m)	
		General requirement	Sparsely inhabited areas
Up to and including 54	100	15	15
Over 54 up to and including 132	10	20	400
Over 132 up to and including 216	10	50	1,000
Over 216	100	15	15

For the purpose of this section, a sparsely inhabited area is that area within 1,000 feet of a community antenna television system where television broadcast signals are, in fact, not being received directly from a television broadcast station.

15.162 Demonstration of compliance.

The operator of each CATV system shall be responsible for insuring that each such system is designed, installed and operated in a manner which fully complies with the provisions of this subpart. Each system operator shall be prepared to show, upon reasonable demand by an authorized representative of the Commission, that the system does, in fact, comply with the rules.

SUBPART E–LOW POWER COMMUNICATION DEVICES

15.201 Frequencies of operation.

a. A low power communication device may be operated on any frequency in the bands 10–490 kHz, 510–1600 kHz and 26.97–27.27 MHz.

b. Other frequencies above 70 MHz may be used for operations of short duration in accordance with the requirements set forth in 15.211.

15.202 Radiation limitation below 1600 kHz.

A low power communication device which operates on any frequency between 10 and 490 kHz or between 510 and 1600 kHz shall limit the radiation so that the field strength does not exceed the value specified in the following table:

Frequency kHz	Distance (feet)	Field strength (uV/m)
10–490	1,000	$\frac{2400}{F(kHz)}$
510–1600	100	$\frac{24000}{F(kHz)}$

15.203 Alternative requirement for operation on frequencies between 160 and 190 kHz.

In lieu of meeting the radiation limitation stated in 15.202, a low power communication device operating on a frequency between 160 and 190 kHz need only meet the following requirements:

a. The power input to the final radio frequency stage (exclusive of filament or heater power) does not exceed one watt.

b. All emissions below 160 kHz or above 190 kHz are suppressed 20 db or more below the unmodulated carrier.

c. The total length of the transmission line plus the antenna does not exceed 50 feet.

15.204 Alternative requirement for operation on frequencies between 510 and 1600 kHz.

In lieu of meeting the radiation limitation stated in 15.202, a low power communication device operating on a frequency between 510 and 1600 kHz inclusive need only meet the following requirements:

a. The power input to the final radio stage (exclusive of filament or heater power) does not exceed 100 milliwatts.

b. The emissions below 510 kHz or above 1600 kHz are suppressed 20 dB or more below the unmodulated carrier.
c. The total length of the transmission line plus the antenna does not exceed 10 feet.
d. Low power communication devices obtaining their power from the lines of public utility systems shall limit the radio frequency voltage appearing on each power line to 200 microvolts or less on any frequency from 510 kHz to 1600 kHz. Measurements shall be made from each power line to ground both with the equipment grounded and with the equipment ungrounded.

15.211 Operation above 70 MHz.

a. Except for telemetering devices and wireless microphones operated in accordance with the requirements of 15.212 and 15.213, a low power communication device, manufactured on or after July 15, 1963 may be operated on frequencies above 70 MHz, provided it complies with all of the following conditions:
1. The radiated field on any frequency from 70 MHz up to and including 1000 MHz does not exceed the limits specified for receivers in 15.63.
2. The radiated field on any frequency above 1000 MHz does not exceed 500 microvolts per meter at a distance of 100 feet.
a.1 – a.5 ....
6. Radiation from the transmitter or associated receiver of radio controls for door openers must not fall within any of the following bands:

MHz	MHz	GHz
73 – 75.4	608– 614	10.68–10.70
108 –118	960–1215	15.35–15.4
121.4–121.6	1400–1427	19.3 –19.4
242.8–243.2	1535–1670	31.3 –31.5
265 –285	2600–2700	88 –90
328.6–335.4	4200–4400	
404 –406	4990–5250	

b. Except for radio controls for door openers and for telemetering devices and wireless microphones operated in accordance with the requirements of 15.212 and 15.213, a low power communications device, manufactured before July 15, 1963, may be operated on any frequency above 70 MHz: *Provided*, it complies with all of the following conditions:

(1) The radiated field on any frequency from 70 MHz up to and including 1000 MHz does not exceed the limits specified for receivers in 15.63.

(2) The radiated field on any frequency above 1000 MHz does not exceed 500 microvolts per meter at a distance of 100 feet.

(3) The device is provided with means for automatically limiting operation to a duration of not more than 1 second, not to occur more than once in 30 seconds.

15.214 Alternative provisions for measuring devices.

a. A low power communication device used for measurement of the characteristics of materials may operate in the frequency bands listed in paragraph (c) pursuant to the provisions in this section.
b. ....
c. The device shall operate within the frequency bands:

15.222 Interference from low power communication devices.

Notwithstanding the other requirements of this part, the operator of a low power communication device, regardless of date of manufacture, which causes harmful interference to an authorized radio service, shall promptly stop operating the device until the harmful interference has been eliminated.

15.238 Withdrawal of certificate of type approval.

a. A certificate of type approval may be withdrawn if the type of equipment for which it was issued proves defective in service and, under usual conditions of maintenance and operation, such equipment cannot be relied on to meet the conditions set forth in this part for the operation of the type of equipment involved, or if any change whatsoever is made in the construction of equipment sold under the certificate of type approval issued by the Commission, without the specific prior approval of the Commission.
b. – d. ....

SUBPART F–FIELD DISTURBANCE SENSORS
(Adopted Oct. 5, 1971)

15.301 **Scope of this subpart.**

This subpart provides rules governing the operation of restricted radiation devices which are used as field disturbance sensors. Typical examples of devices regulated by these rules are microwave intrusion sensors and devices that use RF energy for production line counting and sensing.

15.303 **Restriction on operation.**

No field disturbance sensor may be operated unless it has been certificated and labeled as complying with the requirements of this part.

15.305 **General technical specification.**

a. A field disturbance sensor may be operated on any frequency (including frequencies above 900 MHz) subject to the requirement that the field strength of emissions on the fundamental or on a harmonic or on other spurious frequencies shall not exceed 15 uV/m at a distance of from the sensor. The distance is equivalent in feet to 157 divided by the frequency in MHz.
b. Alternative to paragraph (a) of this section, a field disturbance sensor may be operated on any frequenccy listed in 15.307 subject to the technical requirements set out in 15.307 and 15.309 of this part.

15.307 **Permitted bands of operation.**

The carrier frequency of a field disturbance sensor operating on one of the frequencies listed in 15.305(b) and any modulation components thereof shall be kept within the following band limits:

Nominal operating frequency (MHz)	Band Limits (MHz)
915	± 13
2450	± 15
5800	± 15
10,525	± 25
22,125	± 50

15.309 **Emission limitations.**

a. For a field disturbance sensor operating within any frequency band listed in 15.307, the field strength of emissions on the fundamental shall be limited in accordance with the following:

Frequency (MHz)	Field Strength
915, 2450, 5800	50,000 uV/m at 100 ft.
10,525, 22,125	250,000 uV/m at 100 ft.

b. Spurious emissions (including emissions on a harmonic of any frequency listed in paragraph (a) of this section) shall be suppressed at least 50 dB below the level of the fundamental; however, suppression below 15 uV/m at 100 ft. is not required. For pulsed operation, measured field strength shall be determined from the averaged absolute voltage during a 0.1 second interval when field strength is at its maximum value. Below 1000 MHz, the measurement bandwidth shall comply with the requirements set out in the American National Standards Institute Specifications C63.2-1963 and C63.3-1964. Above 1000 MHz the measurement bandwidth shall be 5 MHz.

15.311 **Interference from a field disturbance sensor.**

b. The operator of a field disturbance sensor who is advised that his sensor is causing interference to an authorized radio service shall promptly stop operating the sensor, and operation shall not be resumed until the condition causing the harmful interference has been eliminated.

15.313 **Certification of a field disturbance sensor.**

The procedure for certification of a field disturbance sensor is basically identical to the procedure for a radio control for a door opener.

15.315 **Description of measurement procedure.**

The report of measurements shall describe in detail the measurement procedure that was used. If a published standard was used, reference to the standard is sufficient, provided any departure from the standard is described in detail.

15.317 **Frequency range over which measurements are required.**

a. For a field disturbance sensor operating below 100 MHz, the spectrum shall be scanned from the lowest frequency generated in the device up to 1000MHz. Field strength for all significant emissions shall be measured and reported.

b. For a field disturbance sensor operating above 100 MHz the spectrum shall be scanned from the lowest frequency generated in the device up to 10 GHz, provided that for sensors operating on frequencies above 5 GHz, the spectrum shall be scanned to the highest frequency feasible, above 10 GHz. Field strengths of all significant emissions shall be measured and reported.

EXTRACTS FROM PART 18 I S M EQUIPMENT

18.3 **Definitions.**

For purposes of the provisions of this part the following definitions in the industrial, scientific, and medical service shall be applicable:

a. . . . .

b. "Medical diathermy equipment" shall include any apparatus (other than surgical diathermy apparatus designed for intermittent operation with low power) which utilizes a radio frequency oscillator or any other type of radio frequency generator and transmits radio frequency energy used for therapeutic purposes.

c. "Industrial heating equipment" shall include any apparatus which utilizes a radio frequency oscillator or any other type of radio frequency generator and transmits radio frequency energy used for or in connection with industrial heating operations utilized in a manufacturing or production process.

d. Miscellaneous equipment shall include apparatus other than that defined in or excepted by paragraphs (b) and (c) of this section in which radio frequency energy is applied to materials to produce physical, biological, or chemical effects such as heating, ionization of gases, mechanical vibrations, hair removal and acceleration of charged particles, which do not involve communications or the use of radio receiving equipment.

e. Ultrasonic equipment shall include any apparatus which generates radio frequency energy and utilizes that energy to excite or drive an electromechanical transducer for the production of sonic or ultrasonic mechanical energy for industrial, scientific, medical or other noncommunication purposes.

f. "Industrial, scientific and medical equipment" (ISM equipment). Devices which use radio waves for industrial, scientific, medical or any other purposes including the transfer of energy by radio and which are neither used nor intended to be used for radio-communication.

g. & h. . . . .

18.13 **ISM frequencies and frequency tolerances.**

The following frequencies are allocated for use by ISM equipment with the tolerance limits specified:

ISM frequency:	*Frequency tolerance*
13,560 kHz	±6.78 kHz.
27,120 kHz	±160.0 kHz.
40,680 kHz	±20.0 kHz.
915 MHz	±13 MHz.
2,450 MHz	±50.0 MHz.
5,800 MHz	±75.0 MHz.
22,125 MHz	±125.0 MHz.

18.14 **Operation on microwave frequencies.**

Except for industrial heating equipment which is regulated by 18.101 through 18.122, inclusive, ISM equipment may be operated on the microwave ISM frequencies (915 MHz, 2450 MHz, 5800 MHz and 22,125 MHz) subject to the following conditions:

a. The emission of radio frequency energy resulting from such operation shall be on the particular frequency and must not exceed tolerance limits associated with each such frequency as set forth in 18.13.

b. The energy radiated and the bandwidth of emissions shall be reduced to the greatest extent practicable.

c. No harmful interference shall be caused to authorized communication services from spurious or harmonic radiation. In the event of such harmful interference, operation of the ISM equipment causing such harmful interference shall cease and shall not be resumed until steps necessary to eliminate such interference have been taken.

SUBPART C—ULTRASONIC EQUIPMENT

18.71 **Operation without a license**

Ultrasonic equipment may be operated without a license: *Provided*, the design and operation complies with the technical limitations for such equipment: *And provided further*, That the equipment has been type approved by the Commission or has been certified pursuant to the requirements of 18.71 to 18.84 and the certificate is attached to the equipment or is prominently posted in the room in which the equipment is being operated; except that ultrasonic equipment operating on frequencies below 90 kHz and generating less than 500 watts of radio frequency power may be operated without license, type approval or certification, if such equipment complies with all other applicable provisions of 18.71 to 18.84.

18.72 **Technical limitations.**

a. Ultrasonic equipment shall be designed and constructed in accordance with good engineering practice with sufficient shielding and filtering to provide adequate suppression of emissions on frequencies outside the ISM frequency bands.

b. Except for ultrasonic measurement equipment that operates over a continuous band of frequencies, the fundamental frequency of operation shall fall outside the frequency bands 490-510 kHz, 2170-2194 kHz, and 8354–8374 kHz.

c. The varying conditions under which Ultrasonic equipment is operated shall not result in radiation exceeding the following limits:

Frequency	Distance *Feet*	Field $\mu V/m$
Up to and including 490 kHz	1,000	$\frac{2400}{\text{Frequency in kHz}}$
Over 490 kHz up to and including 1600 kHz.	100	$\frac{24000}{\text{Frequency in kHz}}$
Over 1600 kHz exclusive of frequencies in the ISM frequency bands.	100	15.

d. The operation of ultrasonic equipment on frequencies below 490 kHz using radio frequency power in excess of 500 watts shall be in compliance with the requirements of this section except that the maximum radiated field permitted may be increased as the square root of the ratio of the generated radio frequency power to 500 watts: *Provided*, that the radiated field shall in no case exceed the field permitted industrial heating equipment: *And providing further*, That equipment used in predominantly residential areas shall not be permitted the increase in field with power as indicated in this paragraph.

e. On any frequency above 490 kHz, the radio frequency voltage appearing on each power line shall not exceed 200 microvolts. On any frequency below 490 kHz, the radio frequency voltage appearing on each power line shall not exceed 1000 microvolts. Measurement shall be made from each power line to ground with the equipment itself both grounded and ungrounded.

18.73 **Type approval.**

a. Manufacturers of ultrasonic equipment desiring to obtain type approval for their equipment may request permission to submit such equipment to the Commission for testing by following the procedure set out in Part 2 of this chapter. The request shall include a statement that at least five units of the model to be submitted are scheduled for manufacture.

SUBPART D–INDUSTRIAL HEATING EQUIPMENT

18.101 Operation without a license.

Industrial heating equipment may be operated without a license: *Provided*, The design and operation of the equipment complies with the technical limitations in this part for such equipment: *And provided further*, That the equipment has been certificated pursuant to the requirements of this part.

18.102 Technical limitations

a. Industrial heating equipment shall be designed and constructed in accordance with good engineering practice with sufficient shielding and filtering to meet the requirements of this part.

b. Industrial heating equipment may be operated on any frequency except frequencies in the bands 490-510 kHz, 2170-2194 kHz, and 8354-8374 kHz. Equipment operating on an ISM frequency may be operated with unlimited radiation on that frequency. Equipment operated on other frequencies must suppress radiation on the fundamental carrier frequency as well as other frequencies as required by this part.

c. Industrial heating equipment designed for operation on an ISM frequency shall be adjusted to operate as close to that ISM frequency as practicable.

d. Radiation of radio frequency energy from any industrial heating equipment on any frequency below 5725 MHz, except ISM frequencies, shall be suppressed so that the radiated field strength does not exceed 10 microvolts per meter at a distance of one mile or more from the equipment.

e. Radiation of radio frequency energy from any industrial heating equipment on any frequency above 5725 MHz, except ISM frequencies, shall be reduced to the greatest practicable.

NOTE: The Commission will establish definite radiation limits for these frequencies as soon as information regarding equipment operating on these frequencies becomes available.

f. Filtering between the industrial heating equipment and power lines must be provided to the extent necessary to prevent the radiation of energy from power lines on frequencies other than ISM frequencies with a field strength in excess of 10 microvolts per meter at a distance of one mile or more from the industrial heating equipment and at a distance of 50 feet from the power line.

18.111 Form of certificate.

a. Certificates issued after April 30, 1961, for industrial heating equipment shall be executed on FCC Form 724 except as provided in paragraph b. of this section.

b. . . . .

18.114 Prototype certification permitted.

a. Provision for prototype certification is made on the basis that production units can be expected to exhibit the same radiation characteristics as those of the prototype. Acceptance of prototype certification is based on representations and field strength measurements made by the manufacturer of industrial heating equipment.

b. . . . .

18.119 Elimination and investigation of harmful interference.

a. The operator of industrial heating equipment that causes harmful interference shall promptly take appropriate measures to eliminate the harmful interference.

b. When notified by the Commission that his installation is causing harmful interference, the operator shall arrange for an engineer skilled in interference measurements and control techniques to make an investigation to ensure that the harmful interference has been eliminated. The Commission may require the engineer making the investigation to furnish proof of his qualifications.

c. & d. . . . .

18.120 Interference to a radionavigation or safety service.

a. If the operator of industrial heating equipment is notified by the Commission that operation of such equipment is endangering the functioning of a radionavigation or a safety service, he shall immediately cease operating the equipment.

b. – d. . . . .

18.121 Interference to other radio services.

a. If the operator of industrial heating equipment is notified by the Commission that operation of such equipment is obstructing or repeatedly interrupting an authorized radio service other than a radionavigation or safety service, he shall take prompt measures to eliminate the harmful interference but need not cease operation unless ordered to do so by the Commission.

b.–d. . . . .

SUBPART E–MEDICAL DIATHERMY EQUIPMENT

18.141 Operation on assigned frequencies.

A station license is not required for the operation of medical diathermy equipment on assigned frequencies provided such operation meets the following conditions:

a. Such operation must conform to the general condition set out in the guarantee or certificate required by paragraphs (c) and (d) of this section. Operation must be confined to one or more of the frequencies:

ISM frequency:	*Frequency tolerance*
13,560 kHz	+6.78 kHz.
27,120 kHz	+160.0 kHz.
40,680 kHz	+20.0 kHz.
915 MHz	+13.0 MHz.
2,450 MHz	+50.0 MHz.
5,800 MHz	+75.0 MHz.
22,125 MHz	+125.0 MHz.

b. Such operation may be without regard to the type or power of emission being radiated. Spurious and harmonic radiations on frequencies other than those specified above shall be suppressed so that such radiations do not exceed a strength of 25 microvolts per meter at a distance of 1,000 feet or more from the medical diathermy equipment causing such radiations.

c. – e. . . . .

18.142 Operation on unassigned frequencies.

A station license is not required for the operation of medical diathermy equipment on frequencies other than those specified in 18.141 a. provided such operation is in accordance with the general conditions of operation set out in the certification required in paragraph b. of this section, and meets the following conditions:

a. The equipment used in such operation shall be provided with a rectified and filtered plate power supply, power line filters and shall be provided with sufficient shielding so that the emission of radio frequency energy generated by such operation, including spurious and harmonic emissions, shall not exceed a strength of fifteen microvolts per meter at a distance of 1,000 feet or more from the medical diathermy equipment on frequencies other than those specified in 18.141 a. under any conditions of operation.

b. . . . .

SUBPART F–RF STABILIZED ARC WELDERS

18.181 Technical specifications.

a. The requirements of this part with respect to electric arc welding devices using radio frequency energy are suspended, subject to the provisions of paragraphs b.–e. of this section, until action is completed in the Docket No. 11467 proceeding with respect to these devices.

b. In the event of interference from electric arc welding devices using radio frequency energy to any authorized radio service, steps to remedy such interference shall promptly be taken . . . .

c. & d. . . . .

e. Broad band type of emissions from arc welding equipment shall be measured by an instrument having performance characteristics similar to the "Proposed American Standards Specification for a Radio Noise Meter–0.15 to 25 Megacycles/second" dated March 1950, published by the American Standards Association Committee on Radio Electrical Coordination C63. Quasi-peak values of field strength shall be measured and used in determining compliance with 18.102. Instruments not having characteristics similar to the above-mentioned standards may be used provided suitable correlation factors are used to adjust the field strength readings to values which would be obtained with an instrument having the desired characteristics.

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Volume II (Jan. 1964) $3.50 Foreign $4.25	Part 2: Frequency Allocations and Radio Treaty Matters: General Rules and Regulations Part 5: Experimental Radio Services (other than Broadcast) Part 15: Radio Frequency Devices Part 18: Industrial, Scientific, and Medical Equipment
Volume III (Jan. 1964) $7.00 Foreign $8.75	Part 73: Radio Broadcast Services Part 74: Experimental, Auxiliary and Special Broadcast Services
(Former part numbers 3 and 4, respectively.)	
Volume IV (Feb. 1962) $3.00 Foreign $4.25	Part 7: Stations on Land in Maritime Services Part 8: Stations on Shipboard in Maritime Services Part 14: Public Fixed Stations & Stations of the Maritime Services in Alaska
(Now renumbered parts 81, 83 and 85 respectively.)	
Volume V (Jan. 1964) $3.75 Foreign $4.75	Part 87: Aviation Services Part 89: Public Safety Radio Services Part 91: Industrial Radio Services Part 93: Land Transportation Radio Services
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(Former part numbers 12, 19, and 20, respectively.)	
Volume VII (Jan. 1963) $2.00 Foreign $2.75	Part 6: International Fixed Public Radio Communication Services (Now renumbered Part 23.) Part 21: Domestic Public Radio Services (Other than than Maritime Mobile) Part 25: Satellite Communications

LOCATION OF FIELD OFFICES

District Offices and their suboffices are located at the following addresses:

Radio district	Address of the Engineer in Charge
1	1600 Customhouse, Boston, Mass. 02109.
2	748 Federal Bldg., 641 Washington St., New York, N.Y. 10014.
3	1005 New U.S. Customhouse, Philadelphia, Pa. 19106.
4	Room 819, Federal Building, Baltimore, Md. 21201.
5	Room 400, Federal Building, Norfolk, Va. 23510.
6	1602 Gas Light Tower, 235 Peachtree Street NE., Atlanta, Ga. 30303. Suboffice: Post Office Box 8004, Room 238, Post Office Building, Savannah, Ga. 31402.
7	Room 919, 51 Southwest First Ave., Miami, Fla. 33130.
8	829 Federal Office Bldg., 600 South St., New Orleans, La. 70130. Suboffice: 439 U.S. Courthouse and Customhouse, Mobile, Ala. 36602.
9	New Federal Office Bldg., 515 Rusk Ave., Room 5636, Houston, Tex. 77002. Suboffice: 239 Federal Bldg., 300 Willow St., Beaumont, Tex. 77701.
10	1314 Wood St., Room 707, Dallas, Tex. 75202.
11	Room 1758, U.S. Courthouse, 312 North Spring Street, Los Angeles, Calif. 90012. Suboffice: Fox Theatre Bldg., 1245 Seventh Ave., San Diego, Calif. 92101.
12	323–A Customhouse, 555 Battery St., San Francisco, Calif. 94111.
13	314 Multnomah Building, 319 Southwest Pine Street, Portland, Oreg. 97204.
14	8012 Federal Office Bldg., First Ave. and Marion, Seattle, Wash. 98104.
15	504 New Customhouse, Denver, Colo. 80202.
16	691 Federal Building and U.S. Courthouse, Fourth and Robert Streets, St. Paul, Minn. 55101.
17	1703 Federal Bldg., 601 East 12th St., Kansas City, Mo. 64106.
18	1872 New U.S. Courthouse and Federal Office Bldg., 219 South Dearborn St., Chicago, Ill. 60604.
19	1029 New Federal Bldg., Detroit, Mich. 48226.
20	328 Federal Bldg., Buffalo, N.Y. 14203.
21	502 Federal Bldg., Post Office Box 1021, Honolulu, Hawaii 96808.
22	Post Office Box 2987, 322-323 Federal Bldg., San Juan, P.R. 00903.
23	Post Office Box 644, Room 53, U.S. Post Office and Courthouse Bldg., Anchorage, Alaska 99501.
24	Room 216, M St. NW., Washington, D.C. 20554.