

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.

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

This section consists of information which should be of importance to all electrical/electronic equipment manufacturers. Before you decide whether or not the FCC regulations apply to your products, you should take the time to read the following information thoroughly. Included are:

1. "Does My Transmitter Need a License?" Bulletin OCE 11, dated January, 1969 (This bulletin contains a list of the FCC regulations and rules and describes how to obtain them).
2. "Operation in the Band 535-1600 kHz Without an Individual License" Bulletin OCE 12, dated September, 1970.
3. "FCC Test Procedure for Wireless Microphones and Telemetering Devices" Bulletin OCE 19, dated January 1969.
4. "FCC Test Procedure for Microwave Ovens" Bulletin OCE 20, dated March 1970.
5. "Industrial Radio Frequency Heaters Require Periodic Inspection" Bulletin OCE 8, dated September 1958.
6. "Attachments to Type Approved Equipment Illegal" Bulletin OCE 10, dated April 1965.
7. Extracts From Part 15 of the Rules and Regulations,—RF Devices
8. Extracts From Part 18 of the Rules and Regulations,—ISM Equipment
9. Location of Field Offices and Monitoring Stations

DOES MY TRANSMITTER NEED A LICENSE?

(OCE BULLETIN 11

January 1969)

Increasing quantities and varieties of miniature transmitters, characterized by small size, light weight and low power are being offered to the public. As a consequence, the question is frequently asked:

"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*.

The operation of noncompatible apparatus may cause interference to radio and TV receivers, or may interfere with other radio systems such as aviation radio employed for the safety of life and property. Interference may be merely of the nuisance type when it temporarily disturbs a TV picture. Or it may be extremely serious when it interferes with aviation communications, radionavigation, or instrument landing systems.

The FCC has promulgated rules and regulations governing the use of radio to promote electromagnetic compatibility. Except as provided by Part 15 of the Commission's Regulations, a radio station license must be obtained before a transmitter may be operated.

Eavesdropping Prohibited: FCC Rules adopted in 1966 prohibit the use of any radio transmitter for eavesdropping, whether licensed or operated without a license under Part 15. See 2.701 and 15.11 in the Appendix. This prohibition does not apply to law enforcement officers operating under lawful authority.

Citizens Radio Service: Low power transmitters may be operated under a station license in the Citizens Radio Service (FCC Rules Part 95) for personal or business communications (short distance only) subject to the limitations in Part 95. *A Citizens Radio Station, or any unit thereof, may communicate only with other units of the same station or with units of another Citizens Radio Station.*

The 27 Mc/s band in the Citizens Radio Service is limited to use for the remote control of objects or devices by radio (Class C stations) or for voice communications (Class D stations). Frequencies in the 460-470 Mc/s band are also available for the above uses by Class A or Class B stations, but are subject to different limitations.

SS Bulletin No. 1001 (available upon request) and FCC Rules Part 95 contain detailed information concerning licensing procedure, technical requirements and permissible communications.

Other Licensed Operation: Low power transmitters may be licensed under other Parts of the FCC Rules when the equipment is to be used for communications in a specific activity to which the regulations apply. See Parts 81 and 83 for licensing in the Marine Services; Part 87 for use and licensing in the Aviation Services; Part 89 for licensing in police, fire, and related fields in Public Safety Services; Part 91 for licensing in an industrial or business enterprise; Part 93 for licensing in land transportation activities; and Part 21 for licensing in the Domestic Public Radio Services.

Equipment used under these Parts must generally be type accepted for licensing. Type acceptance of equipment is based on representations and test data submitted to the Commission by the manufacturer or the prospective licensee. The lists of type accepted equipment are revised periodically, and are available for inspection at the Commission's offices in Washington, D.C., and at each of its field offices. Procedure for type acceptance of equipment is contained in subpart F of Part 2 of the Commission's Rules.

Nonlicensed Operation: Subpart E of Part 15, *LOW POWER COMMUNICATION DEVICES*, provides for operation without a license of devices such as wireless microphones, phonograph oscillators, telemetering transmitters, radio garage door controls, and other similar miniature transmitters. Operation without a license is subject to these three general conditions:

1. That no harmful interference is caused to licensed operations.
2. That the transmitter complies with the technical specifications in Subpart E of Part 15.
3. That the device is tagged with a label certifying that it complies with these requirements.

Note that only certain frequencies may be used. These frequencies are listed in 15.201. Note also the list of prohibited frequencies in 15.211. Other sections of these rules list the maximum signal level that may be emitted or the maximum power and antenna length that may be used. See rules in the Appendix.

There are no restrictions on the type of modulation that may be used or on frequency stability. Care must be taken, however, that the signals transmitted by the device stay within the designated band. The device may be used for any legitimate endeavor. An operator's permit is not required for operation of a *low power communication device*. Call letters are not assigned for use of lower power communication devices; they are assigned to licensed stations only.

A certifying label attesting that the transmitter complies with Part 15 must be attached to each *low power communication device* before operation is permissible. Conscientious and informed manufacturers normally test prototype transmitters for compliance with Part 15 and attach labels to devices offered for sale. *Purchasers of low power transmitters intended for operation without a license under Part 15 should make sure that the devices which they purchase carry the manufacturer's certifying label.*

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.

(a) Licensed Use: Various Commission Rules make provision for licensed use of wireless microphones. A lecturer, square dance caller or entertainer may apply for a license under Subpart L of Part 91 if he meets the eligibility requirements in the Business Radio Service. A person eligible in the Motion Picture Radio Service may apply for a license under Subpart of Part 91. Wireless microphones used by AM, FM and TV broadcast stations may be licensed under 74.437 of Part 74.

(b) Nonlicensed Use: For operation without a license, the wireless microphone must meet the technical provisions of Subpart E of Part 15. The pertinent regulations of Part 15 are reprinted at the back of this bulletin. See 15.201 for the

frequencies that may be used and 15.202 through 15.238 for other requirements. If the microphone operates in the FM band 88-108 Mc/s, it must be *type approved*. (15.212(f), 15.235). If it operates on other frequencies permitted by Subpart E, it must be certificated (15.227, 15.228.) Regardless of which frequency is used, if the wireless microphone causes harmful interference to a licensed radio service, the operation of the wireless microphone must be stopped and may not be resumed until the harmful interference has been eliminated (15.3, 15.4, 15.222).

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.

(a) Licensed Use: Eligible applicants may apply for a license to operate a telemetering station under the Rules governing an established radio service, such as Industrial, Public Safety, etc.

(b) Experimental Operation: To the extent that telemetering is used in an experimental or research project as in medical research, a telemetering transmitter may be licensed in the Experimental Research Service under 5.201 of Part 5 for "communications in connection with research projects when existing communications facilities are inadequate." A station in the Experimental Research Service may be assigned frequencies allocated to the broadcast service, the fixed service, or the land mobile service on a noninterference basis. See FCC Rules Part 5 (Volume II) for the license application procedure.

(c) Nonlicensed Operation: Telemetering transmitters may be operated without a license in the same manner as wireless microphones with the exception permitted by 15.213.

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.

Availability of Rules: The various Rules and Regulations of the FCC may be purchased from the Government Printing Office, Washington, D.C. 20402, at the prices shown below. Purchase of a volume carries with it a subscription for amendments for the life of the volume.

The regulations are also published in Title 47 of the Code of Federal Regulations available in any law library.

Volumes of FCC Rules and Regulations by Categories--
Available on subscription basis from Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Subscription price is for an indefinite period and includes basic volume plus all amendments to be mailed to subscribers by the Superintendent of Documents when issued. Parts will not be sold *separately*, nor can they be supplied by the Commission. Domestic subscription includes U.S. Territories, Canada and Mexico. Do not send orders to the Federal Communications Commission.

**OPERATION IN THE BAND
535-1600 kHz
WITHOUT AN INDIVIDUAL LICENSE
(OCE 12
September 1970)**

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 (Former part numbers 9, 10, 11 and 16, respectively.)
Volume VI (Jan. 1964) \$2.00 Foreign \$2.50	Part 95: Citizens Radio Service Part 97: Amateur Radio Service Part 99: Disaster Communications Service (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

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.

Carrier Current Operation

The second type of operation permitted by Part 15 is described as carrier current operation. In this form of operation the transmitter output is coupled into the AC power network in the building. The RF energy is carried along the wires to every AM receiver that is plugged into this network. Usually, the RF energy does not go beyond the power transformer.

Because some of the RF energy leaks off the wires, receivers in the building that are near the wires will also pick up the signals.

The rules impose a limit on the amount of RF energy that the system is permitted to emit. This limit is 15 microvolts per meter (uV/m) at a distance of $\lambda/2\pi$. This distance may be computed in feet by dividing 157,000 by the frequency in kHz. The 15 uV/m limit must not be exceeded when measured at the specified distance from the transmitter or from any part of the wire network carrying the RF energy. See 15.7 for additional details.

Carrier current systems are not required to be certificated at present. However, in order to be sure that his operation continues to comply with the FCC requirements, the operator should make regular surveys, measurements of field strength around the installation, and keep the results of these surveys on file.

Certification

The FCC requires that a low power communication device be certificated to show that it has been tested and found to comply with the technical specifications in Part 15. The operator should make sure that his transmitter carries this certification label. In addition the operator should check his equipment from time to time to make sure that it continues to comply with these requirements.

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.

CAUTION:

REMEMBER—YOU MAY NOT CAUSE HARMFUL INTERFERENCE. REMEMBER, TOO—WHEN YOU ARE NOTIFIED THAT YOUR OPERATION IS CAUSING HARMFUL INTERFERENCE, YOU MUST STOP OPERATING IMMEDIATELY.

FCC TEST PROCEDURE FOR WIRELESS MICROPHONES AND TELEMETERING DEVICES SUBMITTED FOR TYPE APPROVAL UNDER PART 15 (BULLETIN OCE 19 January 1969)

1.0 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.

2.0 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.)

3.0 Measurement Procedure for Wireless Microphone.

3.1 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.

3.2 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.

3.3 Radiated energy.

3.3.1 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.

3.3.2 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.

3.3.3 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).

3.3.4 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.

4.0 Measurement Procedure for Telemetry Device

4.1 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.

4.2 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 telemetry 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.

4.3 Radiated energy.

4.3.1 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.

4.3.2 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.

4.3.3 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).

4.3.4 Procedure. Measurements shall be made all around the telemetry 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 telemetry 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.

4.4 Pulsed Emissions.

There is no objection to the use of pulsed emission for telemetry operations in the band 88-108 Mc/s, provided the

restrictions on bandwidth and emitted field strength are observed.

4.4.1 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.

4.4.2 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.

FCC TEST PROCEDURE FOR MICROWAVE OVENS SUBMITTED FOR TYPE APPROVAL UNDER PART 18 (BULLETIN OCE 20 March 1970)

1.0 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."

2.0 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.

3.0 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.

4.0 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.

5.0 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.

For type approval, the fundamental emission plus sidebands that exceed the limit for out-of-band radiation must fall within the middle 70% of the permitted band. Typically, for operation at 2450 MHz, this may call for the selection of the magnetron to have its maximum emission in the band 2440 to 2460 MHz.

6.0 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.

7.0 Measurement of Radiated Interference.

7.1 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.

7.2 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.

7.3 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.

7.4 Computations to determine compliance.

The measured field at 10 feet is converted to the field at 1000 feet using the formula

$$E_{1000 \text{ ft}} = K_f E_{10 \text{ ft}}$$

Where K_f is given by:

Frequency	K_f
1830 MHz	.0046
2745	.0070
3660	.0090
4575 and above	.0100

For frequencies between those given in the table, the value of K_f is determined by linear interpolation.

The values of K_f given above were determined from measurements at the Laboratory Test Site. Over level terrain and limiting the height of the measuring antenna to 12 feet, the measured values of K_f given above show good agreement with theory.

In the absence of actual measured values of attenuation, the field may be extrapolated to 1000 ft. using inverse linear variation of field with distance to give conservative results.

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.

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.

On request from the manufacturer, the Commission will retest type approved equipment which is intended to be operated with auxiliary devices attached thereto. A request for retesting may be submitted as follows:

- for medical diathermy equipment with attachment 18.144
- for ultrasonic equipment with attachment 18.82
- for wireless microphones with attachments 15.235

If the combination is found to comply with FCC regulations, an amended type approval will be issued, specifying the auxiliary devices that may be attached and the manner in which the connection must be made.

Since Medical diathermy and ultrasonic equipments may be certificated by the user, he may, if he desires, test the combination in the manner prescribed for certification and prepare an appropriate certificate attesting that the combination complies with the applicable FCC requirements. For ultrasonic equipment, measurements must follow the procedure in 18.78 and the certificate must conform with the provisions of 18.80. For medical diathermy equipment, measurements must be made in accordance with the provisions of 18.143 and the certificate must conform with 18.141 or 18.142 depending on the operating frequency of the equipment. In each case, the type approval number on the medical diathermy equipment or on the ultrasonic equipment **MUST BE OBLITERATED**, since the combination as such, is no longer type approved.

No certification procedure has been provided for wireless microphones in the band 88-108 Mc/s. Accordingly Commission approval must be obtained before an auxiliary device may be attached to a type approved wireless microphone in this band.

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:

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

- 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.
- 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 ($\mu\text{V/m}$)
------------------------------	------------------------------------

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 $\mu\text{V/m}$, 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 $\mu\text{V/m}$.

3. No measurement shall exceed 750 $\mu\text{V/m}$.

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 $\mu\text{V/m}$ 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	$\frac{2400}{F(\text{kHz})}$
510–1600.....	100	$\frac{24000}{F(\text{kHz})}$

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:

- The power input to the final radio frequency stage (exclusive of filament or heater power) does not exceed one watt.
- All emissions below 160 kHz or above 190 kHz are suppressed 20 db or more below the unmodulated carrier.
- 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:

- 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	2690–2700	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:

MHz	MHz
13.554–13.566 26.96–27.28 40.66–40.70	890–940 (See note) 2400–2500 5725–5875 22000–22250

NOTE: The frequency band 890-940 MHz is subject to change pursuant to the reallocation of frequencies that may be made in the band 806-960 MHz in the rule making proceeding in Docket No. 18262.

d. The maximum level of emission from the device shall not exceed:

Fundamental frequency in the band	Emission (uv/in at 100 feet)		
	On fundamental frequency	On harmonic frequencies	On other frequencies
13.554-13.566 MHz.....	15	0.5	0.5
26.96-27.28 MHz.....	32	1.0	1.0
40.66-40.70 MHz.....	50	1.5	1.5
above 890 MHz.....	500	50.0	15.0

e. & f.

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.

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.....	± 0.78 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 μV/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.

b.

18.77 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.

18.83 Prototype certification permitted

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

b. & c.

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 providing 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.

SUBPART H—MISCELLANEOUS EQUIPMENT

18.261 Miscellaneous equipment.

a. The operation without a license of miscellaneous equipment, as defined in 18.3(d), generating radio-frequency power of 500 watts or less, shall be in compliance with the provisions of this part for medical diathermy apparatus.

b. Operation of such equipment generating radio-frequency power in excess of 500 watts shall be in compliance with the requirements for medical diathermy apparatus except that the maximum radiated field permitted shall be increased as the square root of the ratio of the generated power to 500 watts: *Provided*, That the radiated field shall in no case exceed the fields permitted industrial heating apparatus: *And provided further*, That equipment used in predominantly residential areas and operating on frequencies below 1,000 MHz shall not be permitted the increase in field with power as indicated in this paragraph, but shall be subject to the restrictions contained in this paragraph for diathermy equipment.

c.

d. For the purpose of field strength measurements, the location of the miscellaneous equipment may be considered to be the actual physical location of such equipment or, where several such units are grouped within a circle of 200 feet radius or less, the several units may, at the election of the certifying engineer, be considered as a single unit, the location of which will be the center of the smallest enclosing circle: *Provided, however*, that if the certification includes more than one unit, the distance of 1,000 feet at which the maximum permissible radiation is determined shall be decreased by an amount equivalent to the radius of the circle encompassing the several units.

FCC Field Offices on next page

LOCATION OF FIELD OFFICES AND MONITORING STATIONS.

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.

The Marine Offices are located at the following addresses:

Federal Communications Commission, 738 Federal Office Building, 500 Zack Street, Tampa, Fla. 33602.
Federal Communications Commission, Post Office Box 3009, Terminal Island, 300 South Ferry Street, Room 2525, San Pedro, Calif. 90731.

The Class A monitoring stations are located at the following addresses:

Federal Communications Commission, Allegan Monitoring Station, Post Office Box 89, Allegan, Mich. 49010.
Federal Communications Commission, Anchorage Monitoring Station, Post Office Box 6303 Annex, Anchorage, Alaska 99502.
Federal Communications Commission, Canandaigua Monitoring Station, Post Office Box 374, Canandaigua, N.Y. 14424.
Federal Communications Commission, Fort Lauderdale Monitoring Station, Post Office Box 22836, Fort Lauderdale, Fla. 33315.
Federal Communications Commission, Grand Island Monitoring Station, Post Office Box 788, Grand Island, Nebr. 68801.
Federal Communications Commission, Kingsville Monitoring Station, Post Office Box 632, Kingsville, Tex. 78363.
Federal Communications Commission, Laurel Monitoring Station, Post Office Box 40, Laurel, Md. 20810.
Federal Communications Commission, Livermore Monitoring Station, Post Office Box 311, Livermore, Calif. 94551.
Federal Communications Commission, Powder Springs Monitoring Station, Post Office Box 85, Powder Springs, Ga. 30073.
Federal Communications Commission, Santa Ana Monitoring Station, Post Office Box 5126, Santa Ana, Calif. 92704.
Federal Communications Commission, Waipahu Monitoring Station, Post Office Box 1035, Waipahu, Hawaii 96797.
The Class B monitoring stations are located at the following addresses:
Federal Communications Commission, Ambrose Monitoring Station, Post Office Box 1126, Denison, Tex. 75020.
Federal Communications Commission, Chillicothe Monitoring Station, Post Office Box 251, Chillicothe, Ohio 45601.
Federal Communications Commission, Douglas Monitoring Station, Post Office Box 6, Douglas, Ariz. 85607.

**FCC PROBLEMS TO BE DISCUSSED AT
THE 1971 INTERNATIONAL EMC
SYMPOSIUM IN PHILADELPHIA**